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(12) **United States Patent**
Larcher et al.

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(45) **Date of Patent: Feb. 28, 2017**

(54) **MODULAR ELECTRICAL SWITCH DEVICE COMPRISING AT LEAST ONE UNIPOLAR CUT-OFF UNIT AND A SWITCH ASSEMBLY COMPRISING SUCH DEVICES**

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(73) Assignee: **SCHNEIDER ELECTRIC INDUSTRIES SAS**, Rueil-Malmaison (FR)

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§ 371 (c)(1),
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PCT Pub. Date: **Jun. 26, 2014**

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(30) **Foreign Application Priority Data**

Dec. 18, 2012 (FR) 12 62255

(51) **Int. Cl.**
H01H 3/00 (2006.01)
H01H 50/54 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01H 50/54*** (2013.01); ***H01H 50/002*** (2013.01); ***H01H 50/16*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01H 50/002; H01H 50/04; H01H 50/64; H01H 50/18; H01H 50/14; H01H 50/44;
(Continued)

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Primary Examiner — Shawki S Ismail
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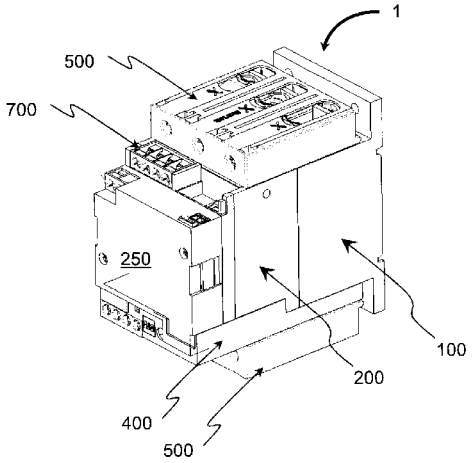
(57) **ABSTRACT**

A modular electrical switch device including: a cut-off unit including unitary cut-off units; an actuating unit of the unitary cut-off units including an electromagnetic actuator including a fixed cylinder head and a movable reinforcement; a mechanism allowing the actuating unit to be fixed to the cut-off unit; a quick attachment mechanism allowing removable fixing of the actuating unit on the cut-off unit, and including at least one coupling hook configured to fix and
(Continued)



hold the cut-off unit to the actuating unit, and to engage with an actuating device of the unitary cut-off unit to transmit movement of the actuator.

15 Claims, 14 Drawing Sheets

(51) **Int. Cl.**

H01H 50/16	(2006.01)
H01H 50/00	(2006.01)
H01H 71/02	(2006.01)
H01H 9/24	(2006.01)
H01H 9/26	(2006.01)

(52) **U.S. Cl.**
CPC ***H01H 71/0228*** (2013.01); ***H01H 71/0235*** (2013.01); *H01H 9/24* (2013.01); *H01H 9/26* (2013.01)

(58) **Field of Classification Search**
CPC H01H 50/54; H01H 50/443; H01H 50/546; H01H 71/0271; H01H 71/082; H01H 71/0228; H01H 9/34; H01H 2071/0278; H01H 50/56–50/66
USPC 335/185
See application file for complete search history.

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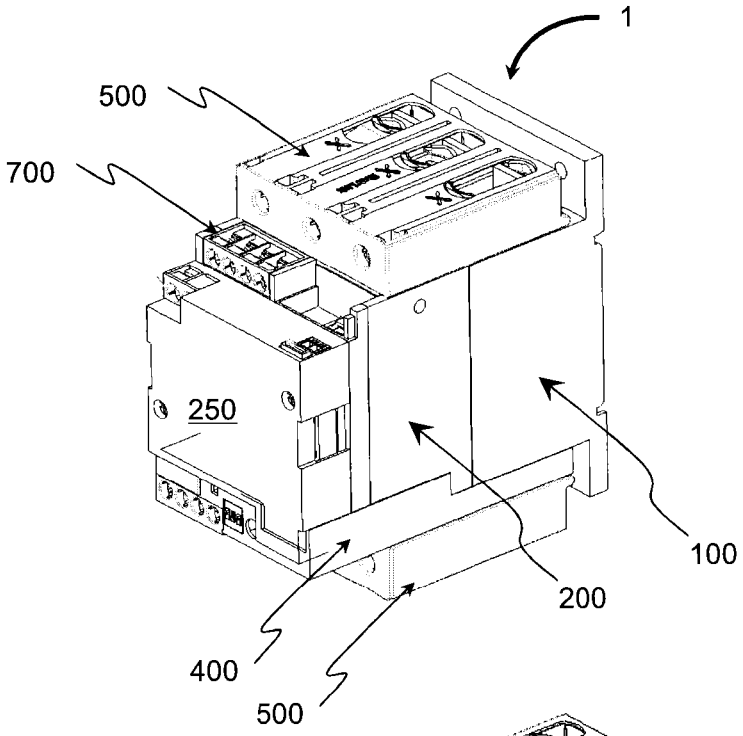
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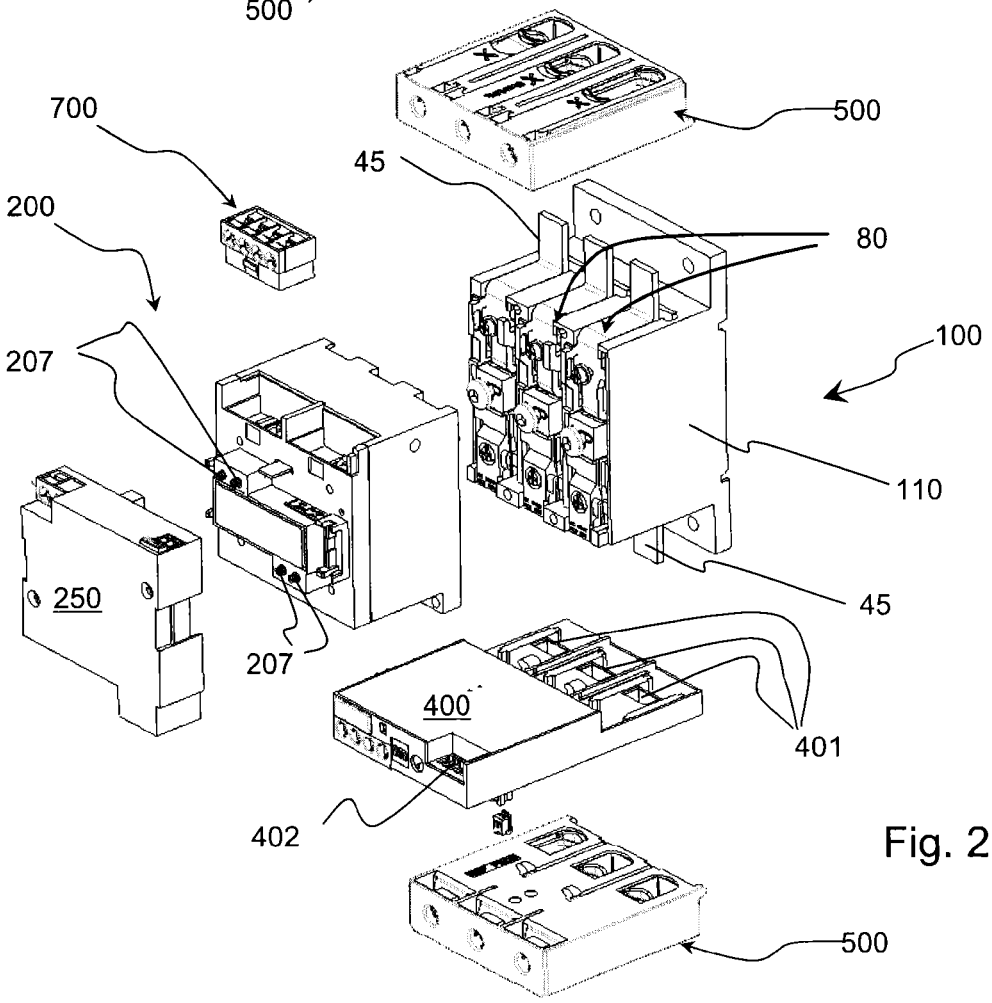
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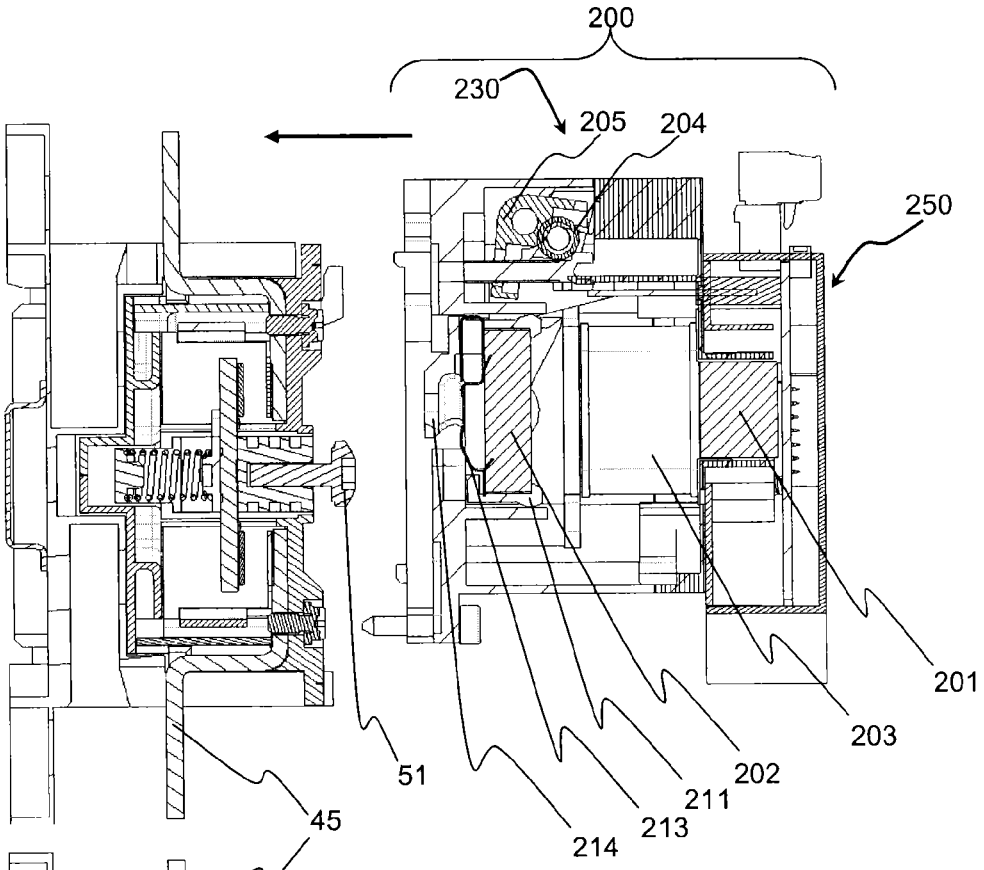
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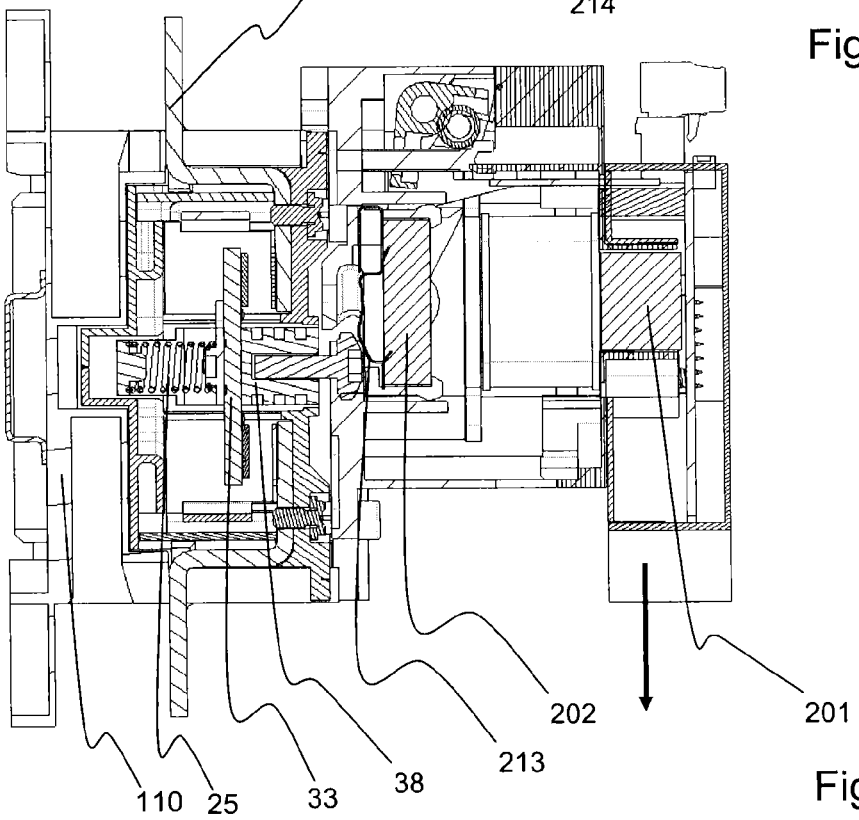
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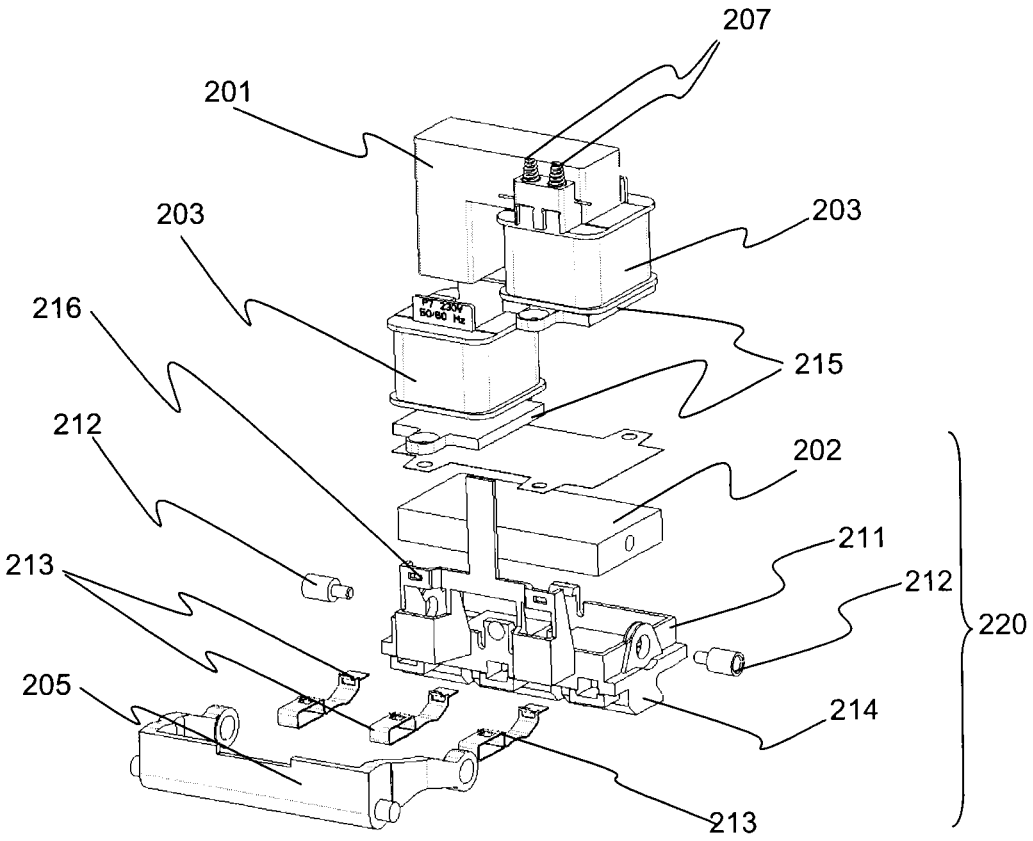
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Fig. 5A

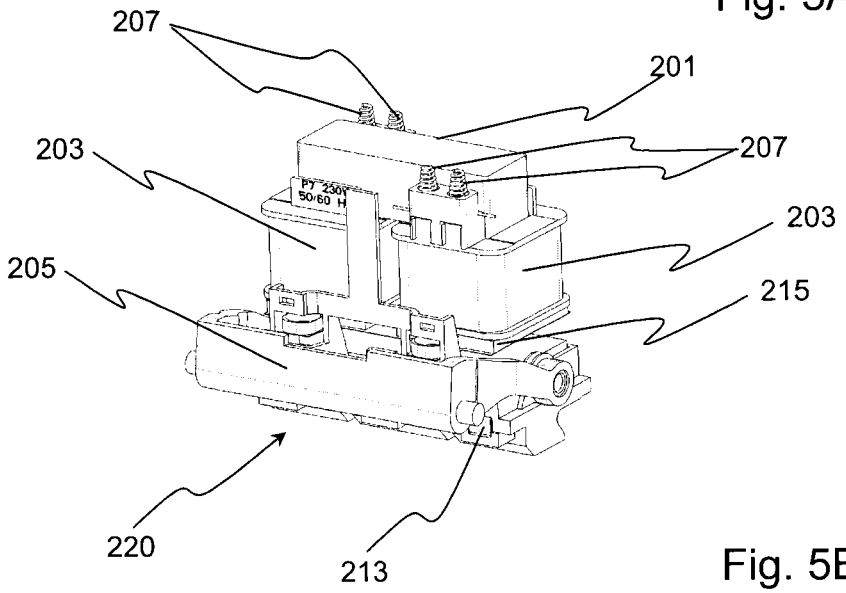
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Fig. 5B

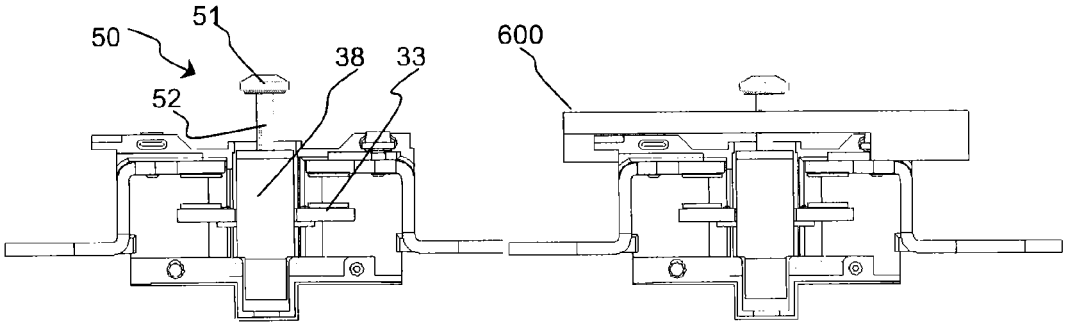


Fig. 6A

Fig. 7A

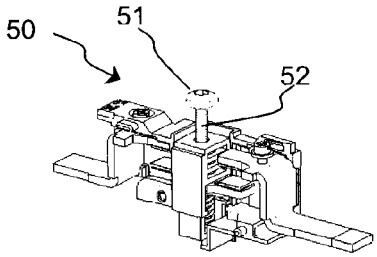
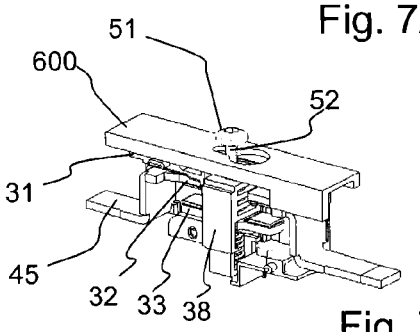


Fig. 6B



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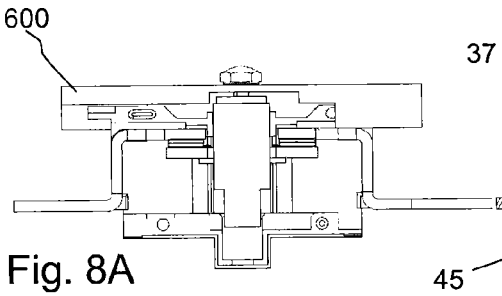
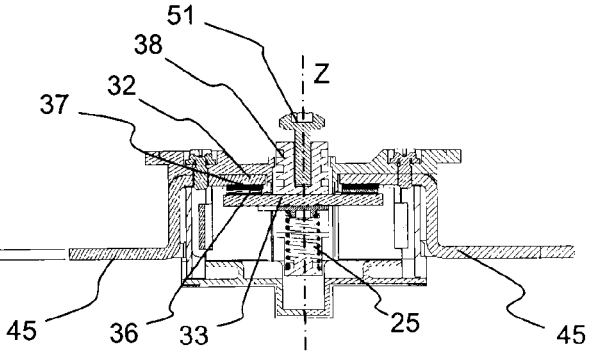


Fig. 8A



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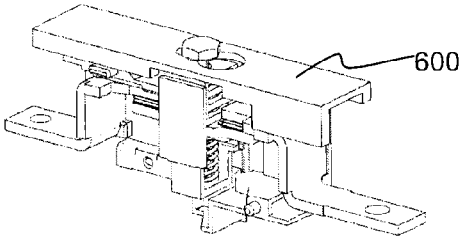

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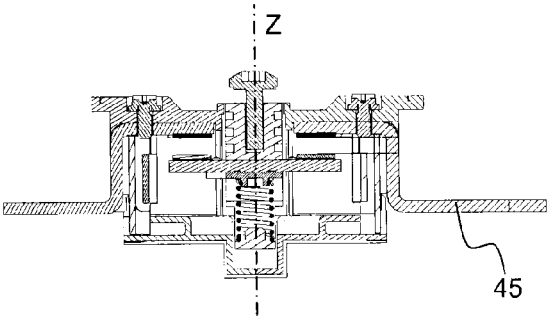

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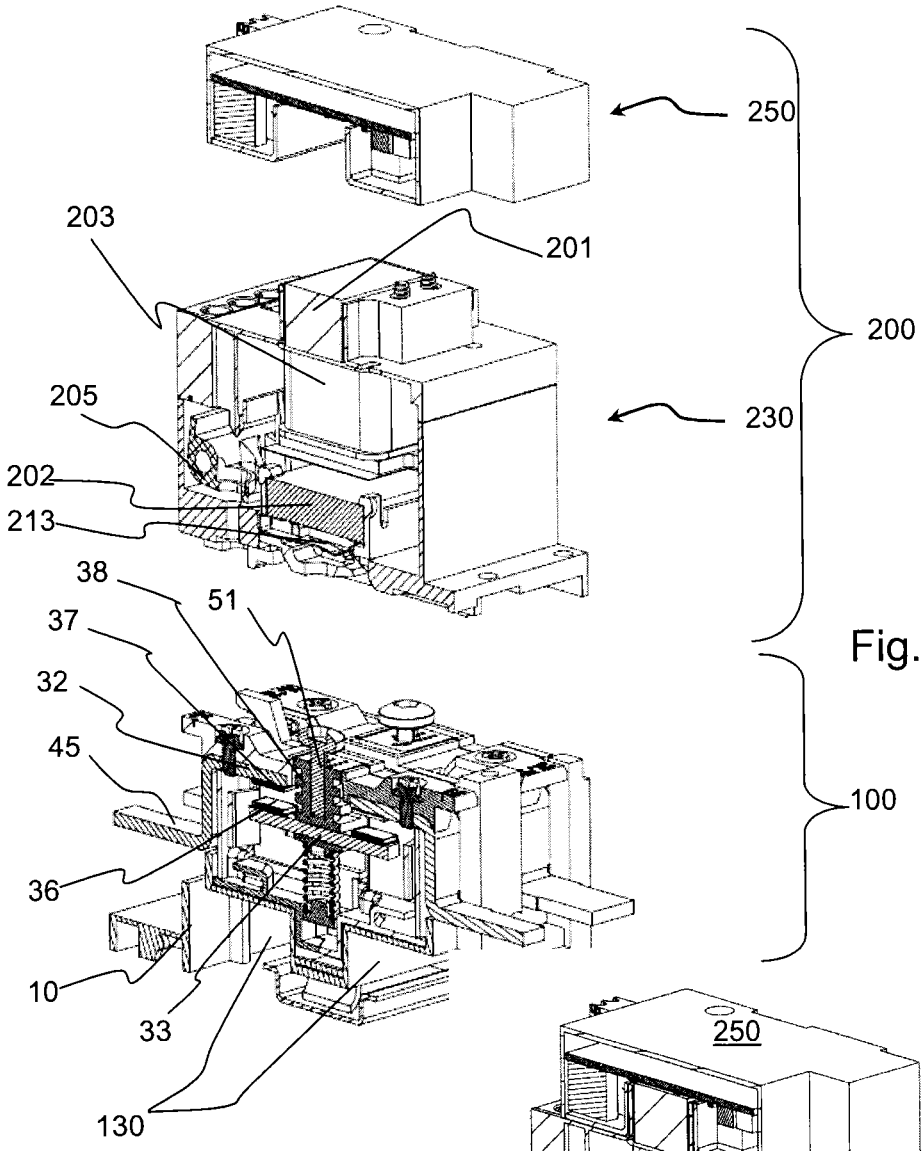

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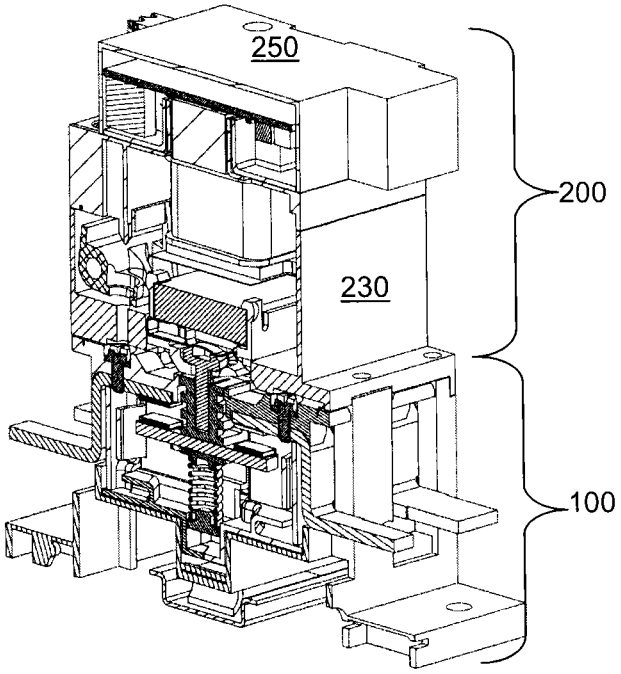

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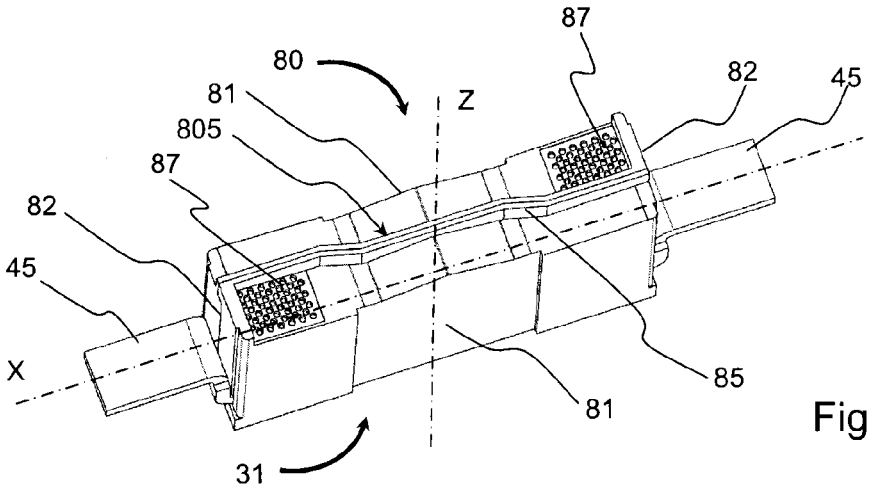

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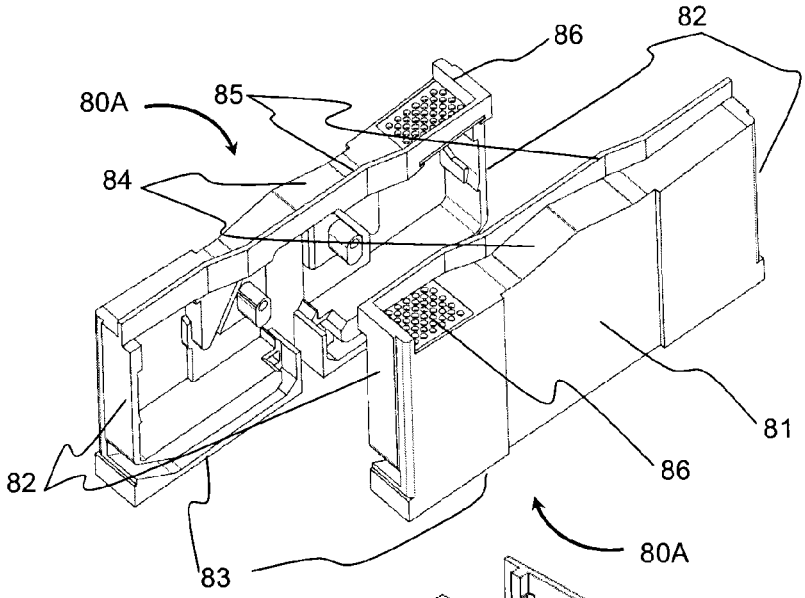

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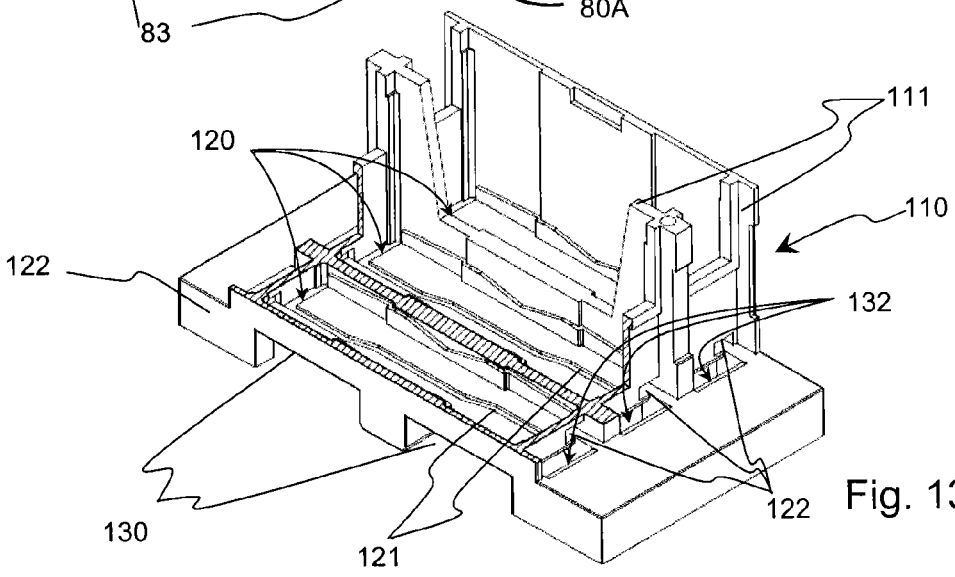

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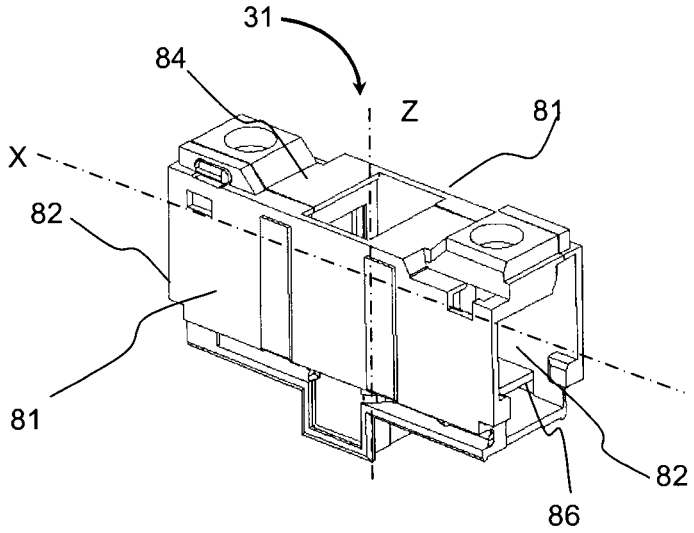

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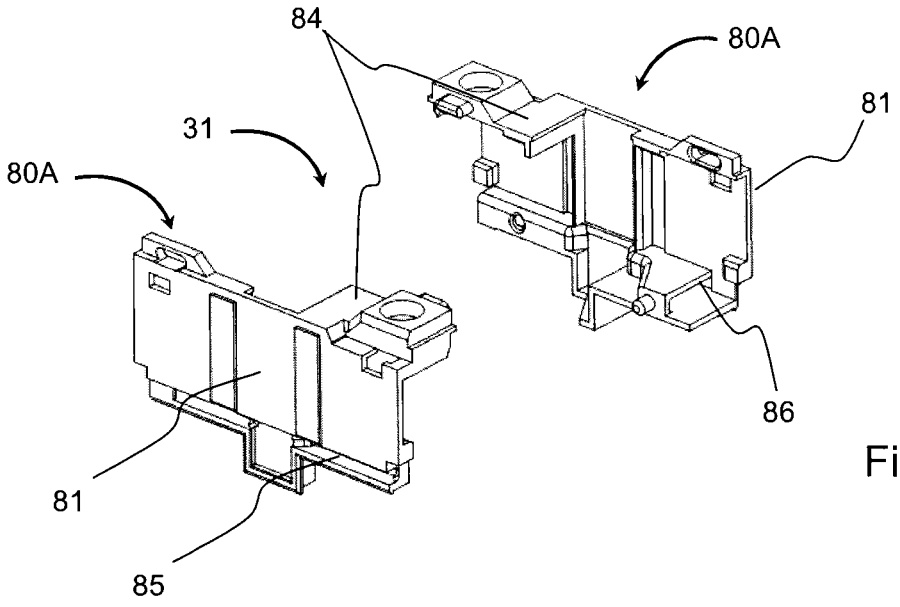

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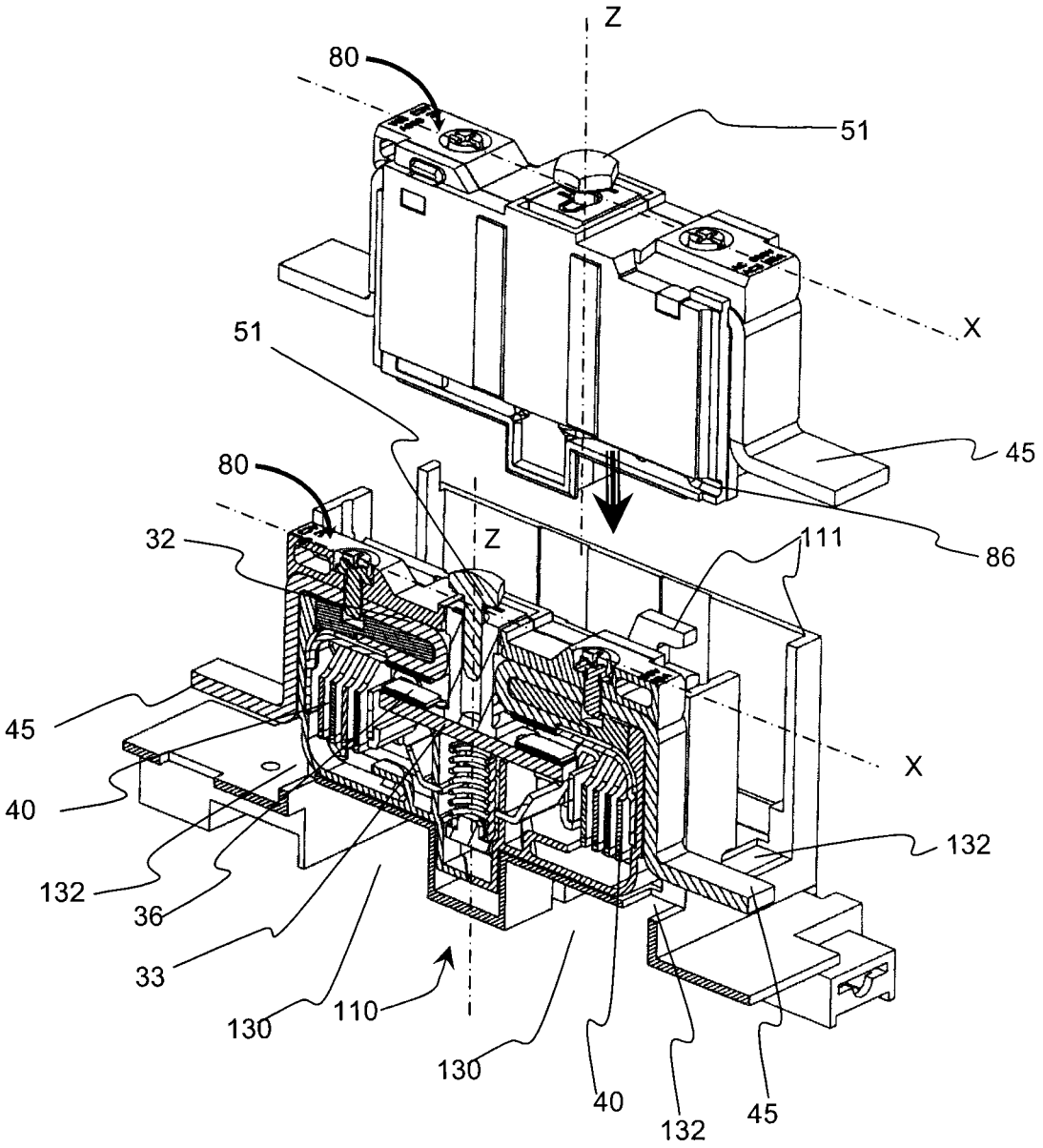
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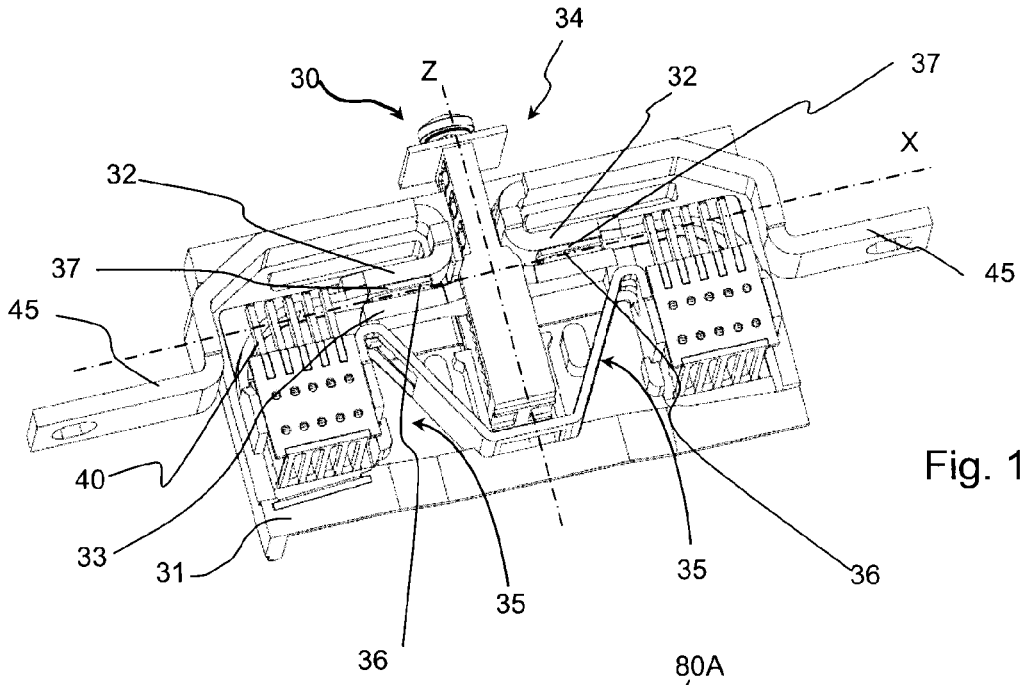
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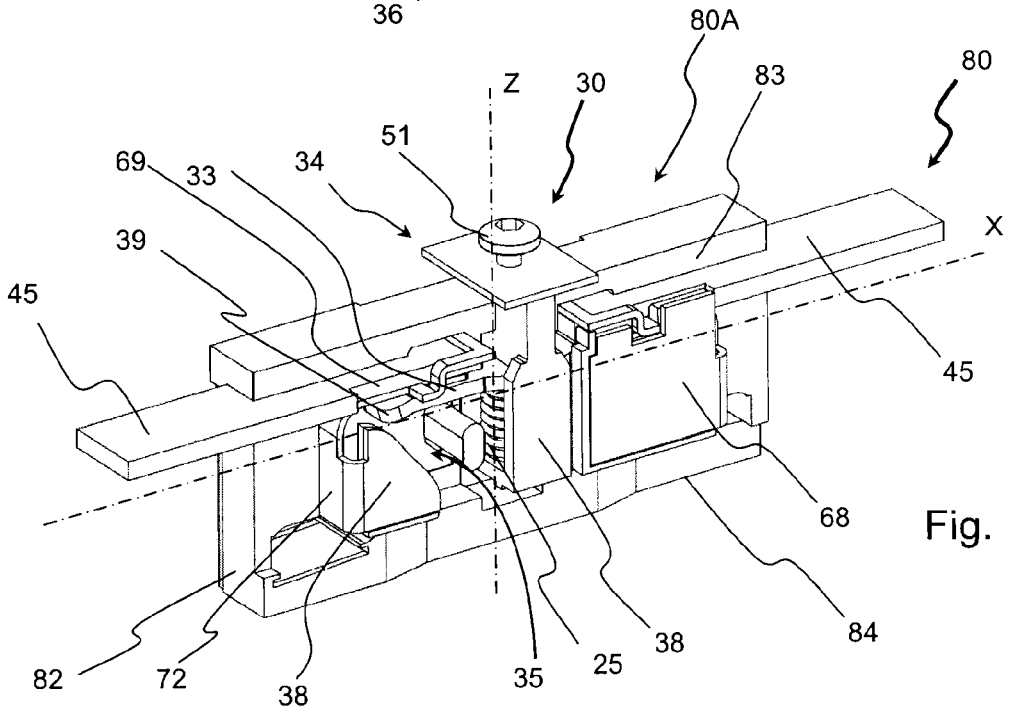
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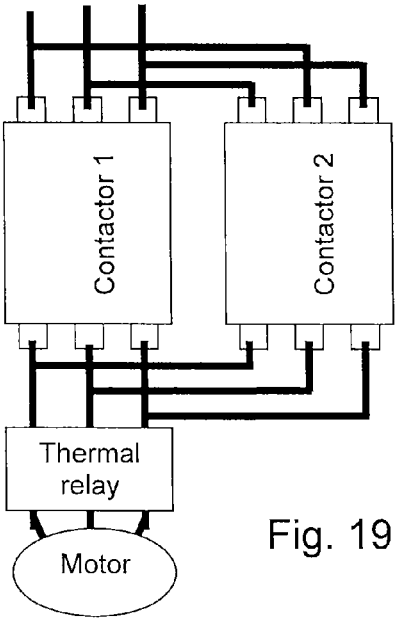
Fig. 18



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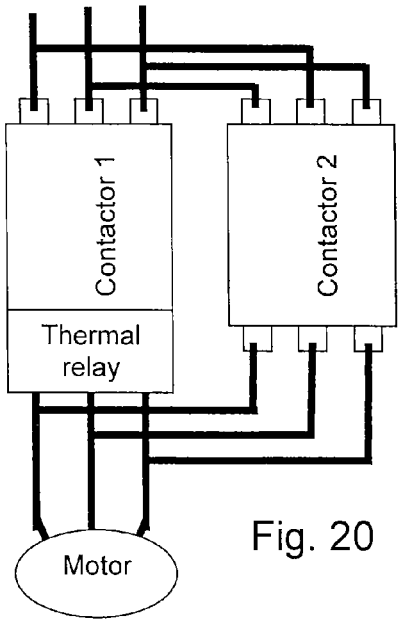

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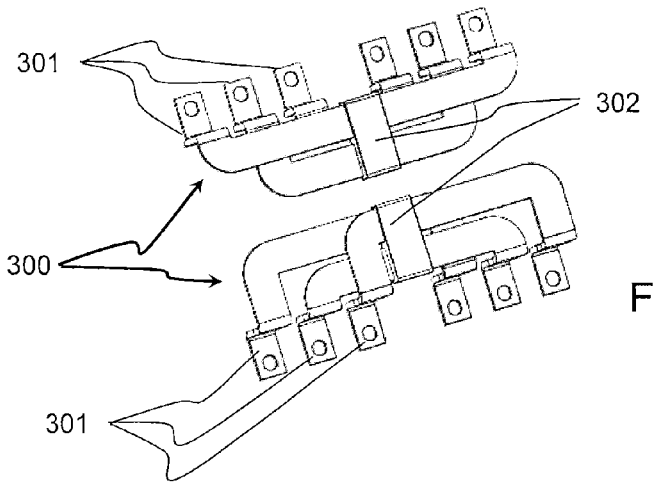

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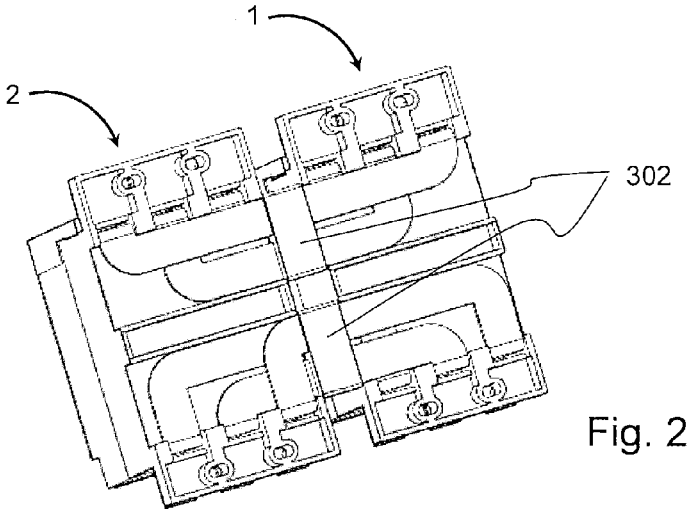

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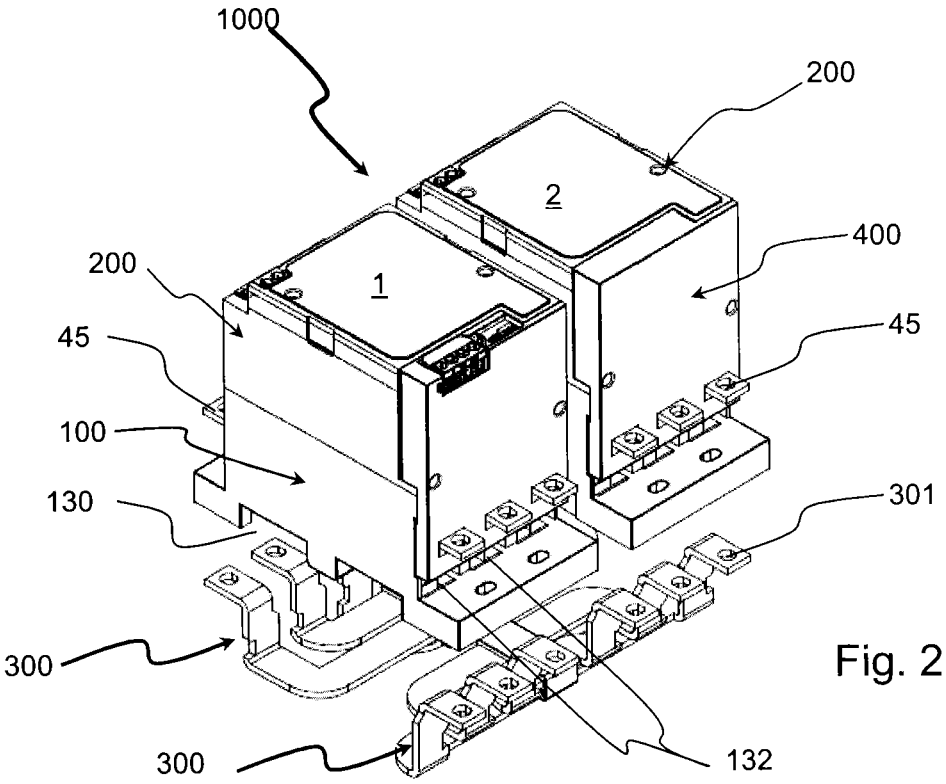
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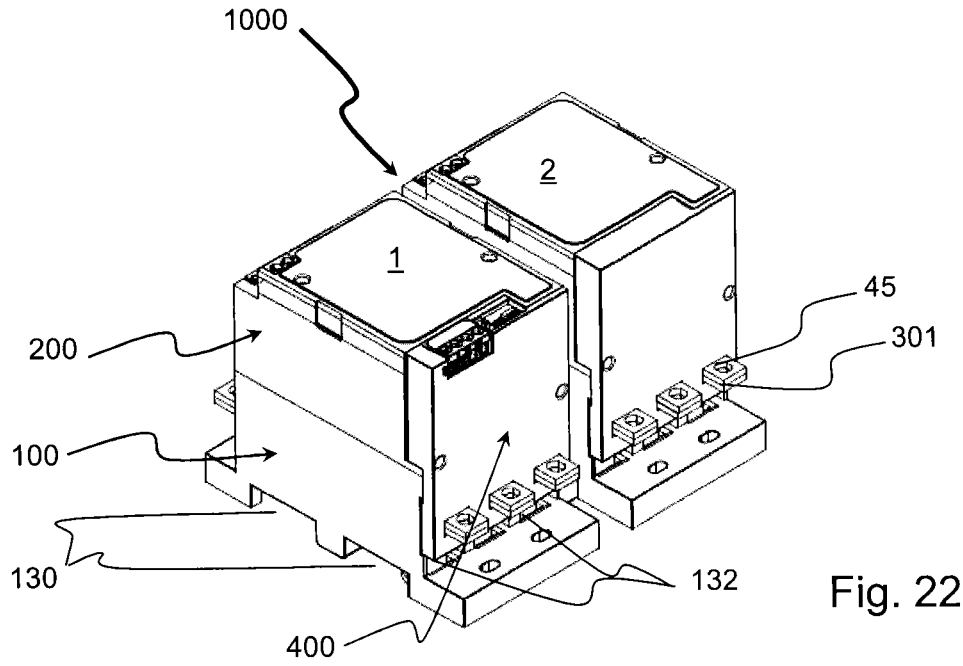
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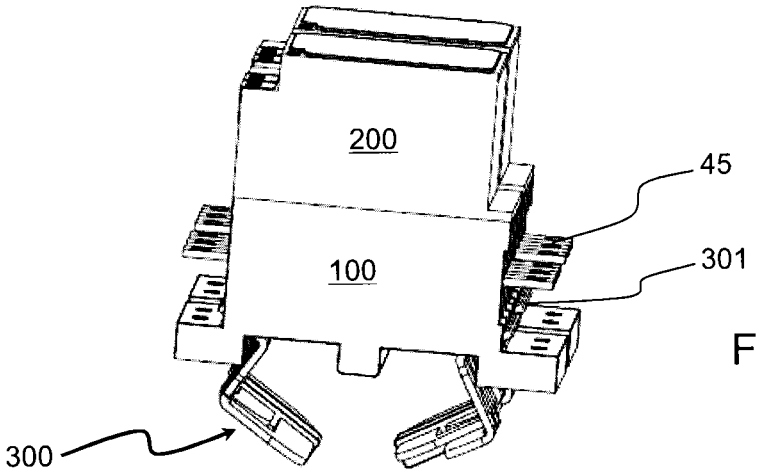
Fig. 22



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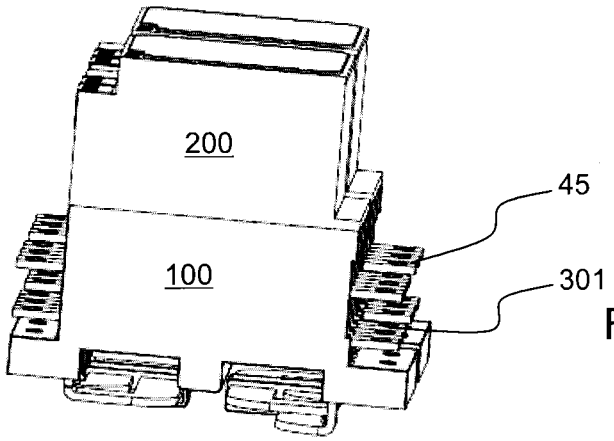

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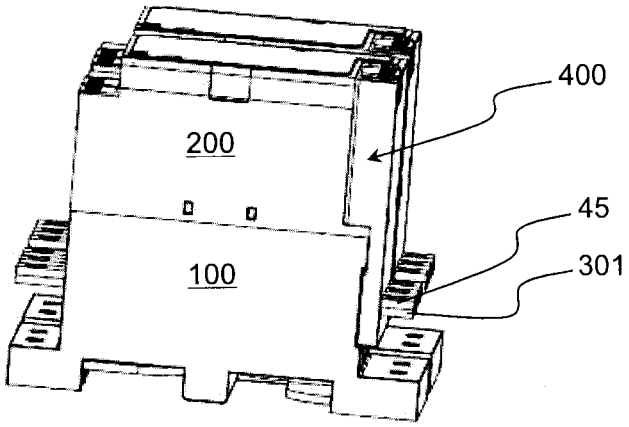

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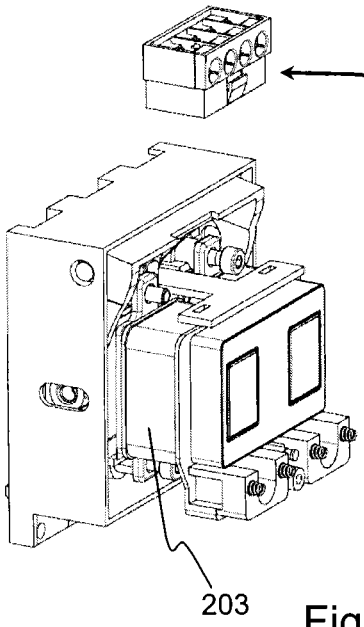

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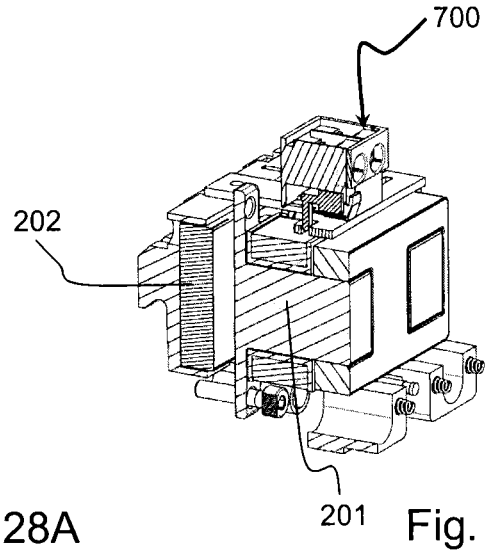

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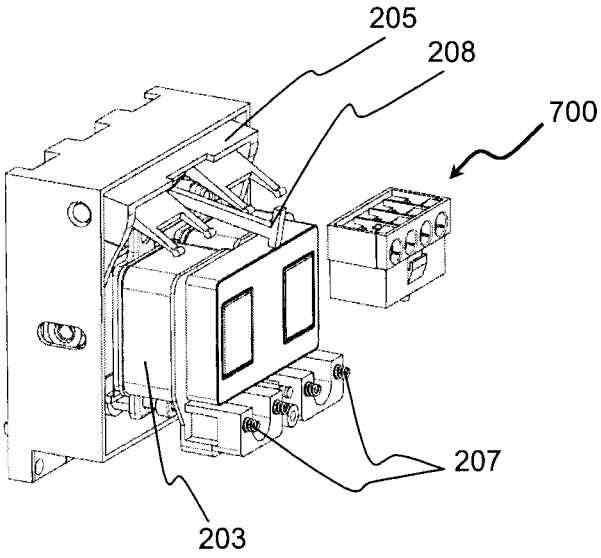

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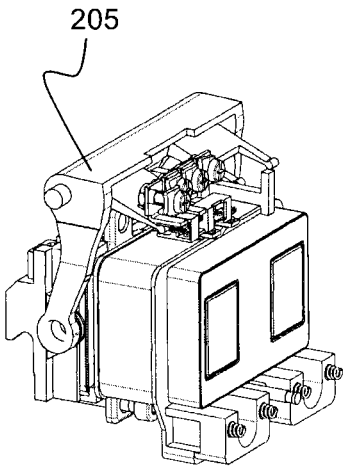

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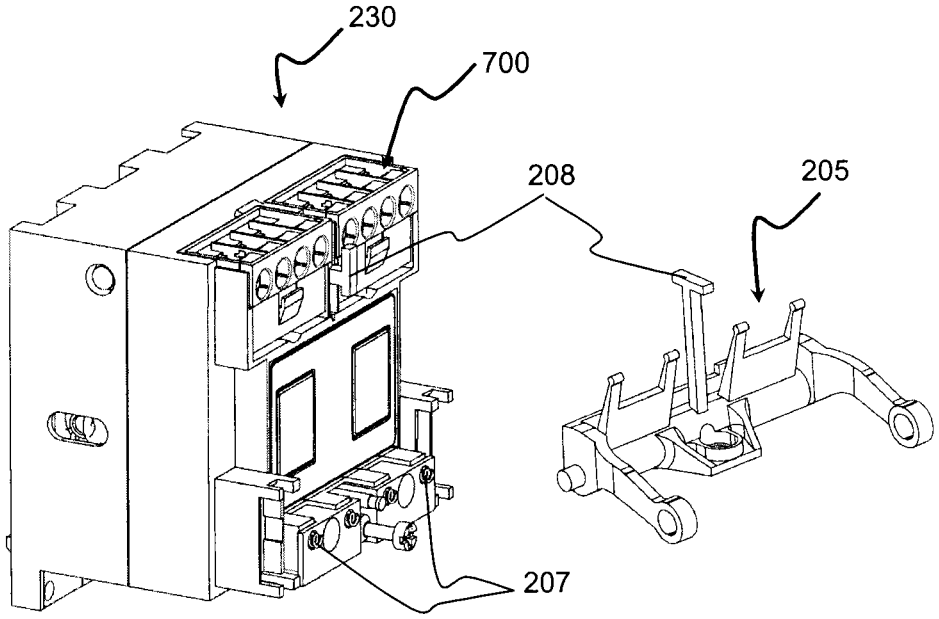
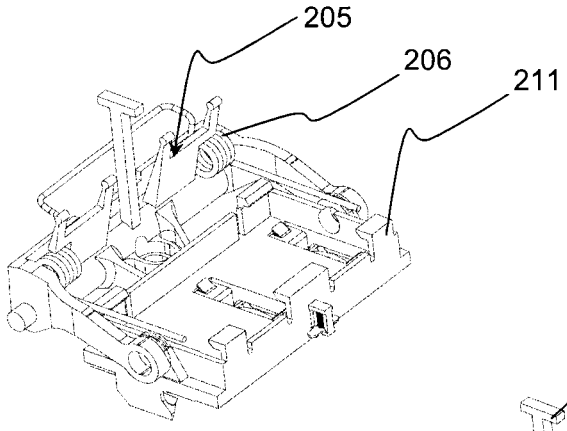


Fig. 30A Fig. 30B



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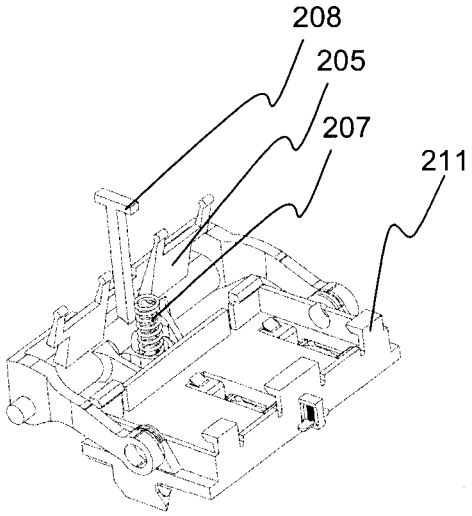

Fig. 31B

MODULAR ELECTRICAL SWITCH DEVICE COMPRISING AT LEAST ONE UNIPOLAR CUT-OFF UNIT AND A SWITCH ASSEMBLY COMPRISING SUCH DEVICES

TECHNICAL FIELD OF THE INVENTION

The invention relates to a modular electrical switching device comprising a switching block comprising unitary switching blocks respectively comprising at least one fixed contact that can collaborate with a mobile contact. An actuation block of the unitary switching blocks comprises an electromagnetic actuator having a fixed yoke and a mobile keeper suitable for being displaced with respect to the fixed yoke between an open position and a closed position of the electrical contacts. The modular electrical switching device further comprises means allowing the actuation block to be fixed onto the switching block.

The invention also relates to an electrical switching assembly comprising a first and a second modular electrical switching device placed side-by-side and being electrically connected.

PRIOR ART

The use of unitary switching blocks in multiple-pole protection and/or switching devices such as circuit breakers, contactor-circuit breakers, and contactors is known. The unitary switching blocks can be housed in a multiple-pole casing (U.S. Pat. No. 4,684,772). The multiple-pole devices are then modular inasmuch as one and the same switching block can be duplicated three times in a three-pole switching device and four times in a four-pole device.

When a number of switching blocks are assembled in a casing of a switching device, there then notably arises the problem of the synchronized control of the different switching blocks. More or less complex existing solutions describe means for controlling and actuating the switching blocks. The use of complex control means can present problems of reliability over time.

Furthermore, some switching devices comprise electrical control means. The use of electrical control means generally greatly reduces the volume of the device and its consumption. It also paves the way for the contactor to have communication. However, if the control means are driven and powered by control electronics, additional problems can appear. In effect, the level and the periods of maintenance required by the electronic means and the electromechanical means included in the same device are not the same bearing in mind that the overall maintenance has to remain easy and inexpensive. This is all the more so since the lifetimes of the electrical control means and of the associated electromechanics can be very different depending on the applications.

Thus, the modularity of the switching device enables the user to obtain a product whose performance levels are truly suited to the use that he or she makes thereof. The corollary of this modularity is the certain complexity of production of such a multiple-pole switching device. The complexity is real in terms of production of the architecture and in terms of the maintenance of the switching device.

The modularity of the multiple-pole switching device can also relate to the installation and the use of an electronic thermal protection device. The incorporation of a removable electronic thermal protection in the volume of the switching device is then possible at the cost of adaptation means of a certain complexity. This additional complexity can be all the greater when a number of switching devices are linked together to control a motor notably according to an installation in reversing switch mode.

DISCLOSURE OF THE INVENTION

The invention therefore aims to remedy the drawbacks of the prior art, by proposing an electrical switching device with electronic control comprising a simplified modular architecture accepting one or more switching blocks.

The modular electrical switching device according to the invention comprises rapid fixing means allowing a removable fixing of the actuation block onto the switching block. Said means comprise at least one coupling hook intended on the one hand to fix and secure the switching block to the actuation block, and on the other hand to collaborate with an actuation device of the mobile contact of a unitary switching block to transmit the movement of the electromagnetic actuator to said mobile contact. Said coupling hook being secured to the mobile keeper of the electromagnetic actuator.

According to a preferred embodiment of the invention, the actuation device of the mobile contact of a unitary switching block comprises a mobile contact-holder secured to the mobile contact and provided with a snug supporting an attachment head.

According to this mode of development, the coupling hook comprises an edge having a bearing surface suitable for collaborating with the attachment head to transmit the movements of the mobile keeper to the mobile contact from the closed position to the open position and vice versa.

Preferably, the coupling hook comprises a first edge having a slot intended to receive an attachment head of the snug, said first edge comprising a bearing surface intended to transmit the movement of the mobile keeper to the mobile contact-holder of the mobile contact in a first direction of movement from the closed position to its open position.

Advantageously, the coupling hook comprises a second edge having a bearing surface intended to transmit the movement of the mobile keeper to the mobile contact-holder of the mobile contact in a second direction of movement, from the open position to its closed position.

According to a particular embodiment, the coupling hook comprises play take-up means suitable for eliminating plays necessary for the mounting of the actuation block on the switching block in order to guarantee that a reduced chain of dimensions is observed in a direction of displacement (Z) of the mobile contact-holder.

Advantageously, the play take-up means comprise an elastic blade positioned substantially parallel to the second edge of the coupling hook, said elastic blade behaving like a blade damper by being deformed in the direction of displacement of the mobile contact-holder as soon as it enters into contact with the attachment head of a snug secured to a mobile contact-holder.

According to a particular embodiment, the attachment head of the snug is mobile relative to the mobile contact-holder, the attachment head being able to be displaced in a direction parallel to the direction of displacement of the mobile contact-holder.

Preferably, the attachment head is linked to the mobile contact-holder by a transmission axis of variable length.

Advantageously, said transmission axis comprises a first end fixed to the attachment head, and a second end having a threading intended to collaborate with a tapping produced in the mobile contact-holder secured to the mobile contact.

According to one mode of development, the modular electrical switching device comprises three unitary switching blocks, the actuation devices of said blocks being

respectively controlled in a synchronized manner by the actuation block to control the opening of the electrical contacts.

Advantageously, the actuation block comprises a tray fixed to the mobile keeper, said tray having three attachment hooks intended respectively to collaborate with an attachment head of a snug of a mobile contact-holder secured to the mobile contact of a unitary switching block.

According to one mode of development, the modular electrical switching device comprises a removable electrical control module positioned and fixed removably on the casing of the actuation block, said module comprising electronic control means to ensure a repetitive and constant operation of the actuator for a wide power supply voltage range.

According to one mode of development, the modular electrical switching device comprises a removable thermal protection module having a casing in which at least one current sensor is intended to be positioned around a connection land of a unitary switching block, said module being inserted removably between the switching block and connection terminal blocks and comprising communication and electrical power supply means intended to be connected automatically with the removable electrical control module to be self-powered and to transmit the measurements performed by the current sensors.

The electrical switching assembly according to the invention comprises electrical conductors positioned respectively in second cavities of the two bases of the two modular contactors.

BRIEF DESCRIPTION OF THE FIGURES

Other advantages and features will emerge more clearly from the following description of particular embodiments of the invention, given as nonlimiting examples, and represented in the attached drawings in which:

FIG. **1** represents a perspective view of a modular electrical switching device according to the invention;

FIG. **2** represents a perspective view of a modular electrical switching device according to FIG. **1** during assembly;

FIG. **3** represents a cross-sectional view of a switching block and of an actuation block according to FIG. **2** in a non-assembled position;

FIG. **4** represents a cross-sectional view of a switching block and of an actuation block according to FIG. **2** in a position during assembly;

FIG. **5**A represents a perspective exploded view of an actuation block of a modular electrical switching device according to FIG. **1**;

FIG. **5**B represents a perspective view of an actuation block of a modular electrical switching device according to FIG. **5**A;

FIGS. **6**A, **7**A and **8**A represent cross-sectional views of a unitary switching block during steps of a method for setting the contact compression travel according to the invention;

FIGS. **6**B, **7**B and **8**B represent perspective views of a unitary switching block during steps of the method for setting the contact compression travel according to the invention;

FIGS. **9**A and **9**B represent cross-sectional views of a unitary switching block respectively in a position of opening and a position of closure;

FIGS. **10**A and **10**B represent partial cross-sectional views of a modular electrical switching device according to the invention during mounting;

FIG. **11** represents two assembled half-shells of a particular embodiment of a unitary switching block of a switching block according to the invention;

FIG. **12** represents the two half-shells of a switching block according to FIG. **11** during assembly;

FIG. **13** represents a perspective view of a base of a switching block according to one embodiment of the invention;

FIG. **14** represents two assembled half-shells of another particular embodiment of a unitary switching block of a switching block according to the invention;

FIG. **15** represents two half-shells of a switching block according to FIG. **14** during assembly;

FIG. **16** represents a perspective view in partial cross section of a switching block according to one embodiment;

FIGS. **17** and **18** represent perspective views of different particular embodiments of the switching means of a unitary switching block;

FIG. **19** represents a wiring diagram of two switching devices placed upstream of a motor in a reversing switch-type mode;

FIG. **20** represents a wiring diagram according to FIG. **19** according to a non-functional embodiment;

FIGS. **21** and **22** represent perspective views of two switching devices wired in a reversing switch-type mode;

FIGS. **23** to **25** represent perspective side views of two switching devices wired in a reversing switch-type mode;

FIGS. **26** and **27** represent perspective views of link bars used to link two modular switching devices in a reversing switch-type mode;

FIGS. **28**A and **28**B represent perspective views of auxiliary contact blocks in a first particular mode of development of the invention;

FIGS. **29**A and **29**B represent perspective views of auxiliary contact blocks in a second particular mode of development of the invention;

FIGS. **30**A and **30**B represent perspective views of a variant embodiment of the control means of the auxiliary contact blocks according to FIGS. **29**A and **29**B;

FIGS. **31**A and **31**B represent perspective views of variant embodiments of a mobile assembly **220** of an actuation block of a modular switching device according to the invention.

DETAILED DESCRIPTION OF AN EMBODIMENT

The modular electrical switching device **1** according to the invention as represented in FIG. **1** comprises a switching block **100** associated with an actuation block **200**. The modular electrical switching device **1** is preferably a contactor. The terms contactor or switching device or modular electrical switching device will hereinbelow be used without distinction.

According to a preferential embodiment of the invention, the modular contactor **1** according to the invention comprises rapid fixing means allowing the actuation block **200** to be removably fixed onto the switching block **100**.

Furthermore, according to this preferential embodiment of the invention, as represented in FIGS. **10**A and **10**B, the actuation block **200** comprises an actuation module **230** connected to a removable electrical control module **250**.

The removable electrical control module **250** can comprise electrical control means powered by control electronics. The terms removable electrical control module **250** or removable electronic control module **250** will be used hereinbelow without distinction.

The actuation module **230** comprises, in a known manner, an actuator of electromagnetic type more particularly comprising a fixed yoke **201** and a mobile keeper **202** suitable for being displaced relative to the fixed yoke **201** between two positions, an open position and a closed position. The electromagnetic actuator also comprises an actuation coil which, when it is passed through by a control current, makes it possible to displace the mobile keeper **202** from its open position to its closed position.

A return spring **204** makes it possible to displace the mobile keeper **202** from its closed position to its open position. According to a particular embodiment as represented in FIGS. **3** and **4**, the return spring **204** acts on the mobile keeper **202** via a rotary lever **205**.

According to a preferential mode of development of the actuator represented in FIGS. **5**A, **5**B, the fixed keeper **201** comprises a U-shaped section comprising two outer branches and a transverse keeper secured to a first end of the outer branches. The actuator comprises an actuation coil preferably comprising two electrically linked control windings **203**. The two windings respectively comprise a longitudinal axis substantially merged with that of the outer branches of the U-shaped magnetic yoke. In effect, said control windings **203** are wound on insulating field frames placed on the outer branches of the magnetic yoke **201**. The two control windings **203** are preferentially identical.

According to an embodiment of the invention as represented in FIGS. **5**A and **5**B, the return spring **204** is suitable for displacing a mobile assembly **220** from its closed position to its open position. As represented in FIG. **5**B, the mobile assembly **220** comprises the mobile keeper **202** of the actuator positioned in a tray **211**. The return spring acts on a multifunction lever **215** secured to the tray **211**. Said multifunction lever **205** is arranged to manage a balancing of the mobile keeper **202** in order to allow simultaneous closure of the three power poles while reducing friction.

As represented in FIGS. **29**A and **29**B, the multifunction lever **205** also makes it possible to drive the auxiliary contact blocks and provide an indication on the front face of the modular electrical switching device **1**.

As represented in FIGS. **31**A and **31**B, the multifunction lever **205** can be controlled in two ways. As represented in FIG. **31**A, a torsion spring **206** is used to keep it in an operating position. As represented in FIG. **31**B, a compression spring is used to keep it an operating position.

The actuator also preferably comprises pole plates **215** fixed onto the outer branches of the U-shaped magnetic yoke. Said plates make it possible to improve the magnetic behavior of the actuator.

The actuator can be of monostable or bistable type. In the case of a bistable actuator, said actuator comprises at least one permanent magnet preferably placed between the two pole plates **215**.

According to one mode of development of the invention not represented, the magnetic yoke **201** comprises an E-shaped section having two outer branches, at least one central branch, and a transverse keeper secured to a first end of the outer and central branches. The mobile keeper is placed facing the second ends of the outer branches and is displaced in translation. The mobile keeper also comprises an E-shaped section comprising two outer branches, at least one central branch, and a transverse keeper secured to a first end of the outer and central branches. The control coil comprising a longitudinal axis substantially merged with that of the central branch of the E-shaped magnetic yoke. In effect, said control coil comprises a winding wound on an insulating field frame placed on the central branch of the magnetic yoke.

The actuator is positioned in a casing of the actuation module **230**. The control windings **203** of the actuation coil comprise connection terminals **207** intended to come into contact with adaptive connection means of the removable electrical control module **250**. As represented notably in FIG. **5**B, each control winding **203** comprises two connection terminals **207**.

According to a first exemplary embodiment as represented in FIG. **28**A, the four connection terminals **207** of the two control windings **203** are preferably aligned. According to a second exemplary embodiment as represented in FIG. **5**B, the four connection terminals **207** of the two control windings **203** are preferably arranged diagonally. These two arrangements of the terminals **207** notably make it possible to adapt to different configurations of the removable electrical control module **250**.

According to this preferential embodiment of the invention, the removable electrical control module **250** comprises electronic control means powered by control electronics. The removable electronic control module **250** is then intended to ensure a repetitive and constant operation of the actuator for a wide power supply voltage range. Said removable electronic control module is positioned and fixed on the casing of the actuation module **230**. At the time of its positioning on said casing, the connection terminals **207** of the control windings **203** are automatically interconnected with the adaptive connection means of the removable electronic control module **250**. According to a preferential embodiment, the adaptive connection means are incorporated directly on a printed circuit board PCB of the removable electrical control module **250**. Depending on the version of the electronic control means used and depending on the control voltage of the modular contactor, the connection between the two control windings **203** shrewdly distributed on the two outer branches of the magnetic yoke **201** of the actuator can be made in series or in parallel. The adaptive connection means allow for a series or parallel connection of the two control windings **203** at the time of the connection of the removable electrical control module **250** to the actuation module **230**. The adaptive connection means thus allow for a wider adaptation to the needs of the application while retaining an actuation coil that is common to all the applications.

According to a first particular embodiment of the adaptive connection means, the printed circuit board (PCB) of the removable electrical control module **250** comprises electrical tracks designed and configured in order to connect the terminals **207** of the control windings **203** in series.

According to a second particular embodiment of the adaptive connection means, the printed circuit board (PCB) of the removable electrical control module **250** comprises electrical tracks designed and configured in order to connect the terminals **207** of the control windings **203** in parallel. The control commands and the power supply for the control windings **203** pass via these connection terminals **207**.

This removable electrical control module **250** can comprise a number of variants depending on the application targeted (notably depending on the network voltage). Said module is preferably mounted last on a contactor or a contactor equipped with a thermal protection (starter). The final choice of the electrical control module to be installed thus allows the installer to make a delayed differentiation. This removable electrical control module **250** can also be

provided with connections allowing for communication, for example with a management computer of the installation, or a configuration tool.

The switching block **100** of the contactor **1** according to the invention comprises one or more electrical poles. According to the embodiment represented in FIGS. **1** and **2**, the contactor comprises three electrical poles, and it is therefore called three-pole contactor. A unitary switching block **80**, also commonly called switching bulb is then associated with each electrical pole. The three unitary switching blocks **80** are then controlled in a synchronized manner by the actuation block **200** acting on actuation devices **34** of the unitary switching blocks **80**.

According to a particular embodiment, the switching blocks can be controlled in a synchronized and simultaneous manner. In other words, all the blocks are displaced then at the same time.

According to another particular embodiment, the switching blocks can be controlled in a synchronized and non-simultaneous manner. In other words, all the blocks are displaced by virtue of the action of the actuation block but a time offset is observed between the displacement of each block. This time offset is reproducible and controlled.

As represented in FIGS. **12** and **15**, the unitary switching blocks **80** according to the invention comprise a casing **31** formed by two half-shells **80**A. The two half-shells **80**A of the casing **31** are preferably made of molded plastic material. Electrical contacts are positioned inside the casing **31**. The half-shells **80**A are assembled to form an assembly of substantially parallelepipedal form developing in a longitudinal plane of reference XZ.

According to a particular embodiment, the two half-shells **80**A forming the casing **31** are preferably of identical form. As an example, "identical form" should be understood to mean the fact that the two half-shells, preferably produced by molding, are obtained from one and the same die. This offers the industrial advantage of managing a single variant part and a single investment. The casing **31** then comprises two main faces **81** arranged parallel to the longitudinal plane XZ. Said casing further comprises two lateral faces **82**, a top face **83** and a bottom face **84**.

As represented in FIGS. **16** and **17**, the unitary switching block **80** comprises electrical switching means **30** consisting of two fixed contacts **32** respectively linked to an electrical connection terminal block **500** by connection lands **45**. The two fixed contacts **32** respectively comprise an electrical contact area **37**. The electrical switching means **30** are then positioned in an internal volume of the casing **31**, an internal volume delimited by the two half-shells **80**A.

The electrical switching means **30** further comprise a mobile contact **33** in the form of a bridge comprising an elongate body along a longitudinal axis X. According to this embodiment, the mobile contact bridge **33** comprises two ends on which are positioned two contact areas **36** that can each respectively collaborate with a contact area **37** of a fixed contact **32** in a position of closure of the switching means.

The terms "mobile contact" or "mobile contact bridge" will be without distinction hereinafter in the description.

In this position of closure, an elastic means **25**, such as, notably, a helical spring, makes it possible to ensure, between the contact areas **36** and **37**, a sufficient contact pressure to guarantee the establishment and the flow of current in good conditions. The elastic means **25** is generally called pole spring. This contact pressure is also provided for the permanent flow of current without excessive overheating, and to guarantee sufficient electrical durability.

Two opening volumes **35** are thus defined, corresponding to the space in which a contact area **37** of a fixed contact **32** and a contact area **36** associated with the mobile contact **33** are arranged. Furthermore, each opening volume **35** is associated with an arc-extinguishing chamber. The arc-extinguishing chamber opening onto the opening volume **35** is delimited by two parallel walls placed either side of the longitudinal geometrical plane of reference XZ, a back wall away from the opening volume **35**, a bottom wall and a top wall.

According to an embodiment of the arc-extinguishing chamber, said chamber can comprise a stack of at least two planar metal plates **40** at right angles to the longitudinal geometrical plane of reference XZ. These metal plates, called fins, are intended to deionize the arc. The metal plates **40** are preferably made of ferromagnetic material. Said fins tend to exert a ferromagnetic attraction force on the arc. Said fins are of substantially rectangular form and comprise a longitudinal axis and a median axis.

According to another particular embodiment of the arc-extinguishing chamber as represented in FIG. **18**, said chamber is delimited by two flanges **68** of ferromagnetic material. The two lateral flanges **68** are parallel and placed either side of a median longitudinal plane XZ. The two lateral flanges **68** are arranged in such a way as to frame one of the ends of the mobile bridge **33** over its entire displacement between the position of opening and the position of closure. In other words, the two lateral flanges **68** are spaced apart from one another to allow the displacement of the mobile contact bridge **33**. The internal walls of said flanges **68** comprise a layer of insulating material. The positioning of the layers of insulating material on the flanges **68** makes it possible to avoid the attachment of the arc on the internal walls of said flanges **68**. These layers are preferably made of gasogenic material.

The extinguishing chamber is also delimited by a back wall **72** placed at right angles to the plane XZ. Said back wall is away from the opening volume **35** to be positioned opposite an opening volume of the contact areas **36**, **37**. The back wall **72** links the two lateral flanges **68** so as to form a substantially U-shaped metal assembly. The back wall **72** links the two flanges over a part of their height.

Preferably, the two lateral flanges **68** extend in a direction parallel to the median longitudinal plane XZ so as to entirely frame the contact area **36** of the mobile contact bridge **33**. More specifically, the two lateral flanges **68** extend in such a way as to completely enclose the contact area **36** of the mobile contact bridge **33** inside the arc-extinguishing chamber **24**. In other words, the development of the flanges lengthwise makes it possible to laterally close each opening volume **35** so as to channel the outflow of ionized particles at the time of opening of the electrical contacts.

The wall of each arc-extinguishing chamber **24** can include a top metal baffle **69**. As represented in FIG. **18**, said baffle electrically links a fixed contact **32** to a back wall **72** to form a top part of the metal wall of said extinguishing chamber.

According to a variant embodiment, the mobile contact bridge **33** comprises arcing horns **39** at each of the two ends. Said arcing horns extend beyond the contact areas toward the back walls **72** of the arc-extinguishing chambers. By way of exemplary embodiment, the arcing horns **39** are inclined relative to the longitudinal axis X of the mobile contact bridge **33**.

The casing **31** of the unitary switching block **80** is intended to be positioned in a base **110** of the switching block **100** of the contactor **1**. The base **110** comprises an

inner face having a first cavity **120** in which unitary switching blocks **80** are positioned. The bottom face **84** of the casing **31** is then positioned facing into the first cavity **120** of the base **110**. The main faces **81** are attached to separating partitions **111** of the base **110**. The separating partitions **111** positioned on the outer edges of the base **110** thus form walls of the modular electrical switching device **1**.

The base **110** comprises a first cavity **120** having at least three compartments intended to collaborate respectively with a unitary switching block **80**. Each unitary switching block **80** cooperates with the base **110** to produce at least one outflow channel for the extinguishing gases allowing for a switching without noise or ionized gases outside the base.

According to a particular embodiment of the unitary switching blocks as represented in FIGS. **11** to **13**, the two half-shells according to the invention are intended to collaborate with a compartment of the first cavity **120** of a base **110** of a modular electrical switching device **1** in order to delimit two outflow channels for the extinguishing gases. Each outflow channel is then linked to an internal volume of the casing **31** by an opening **86** produced in a half-shell **80**A. The half-shells respectively comprise a rib **85** intended to collaborate with a compartment of the first cavity **120** of a base **110** of a modular electrical switching device **1** in order to delimit the outflow channels for the extinguishing gases.

According to a first variant embodiment as represented in FIGS. **11** to **13**, the ribs **85** of the two half-shells **80**A assembled together form, in a contact plane, a bottom rib **805** on the bottom face **84** of the casing **31**. The bottom rib **805** develops in a direction parallel to the longitudinal plane XZ. Said rib is intended to collaborate with the first cavity **120** of a base **110** of a modular electrical switching device **1** in order to delimit two outflow channels for the extinguishing gases, each channel being linked to an internal volume of the casing by an opening **86** produced in a half-shell **80**A. In effect, the casing **31** of the unitary switching block **80** is intended to be positioned in a base **110** of a modular electrical switching device **1**. The bottom face **84** of the casing **31** is then positioned facing a first cavity **120** of the base **110**. More particularly, the bottom rib **805** present on the bottom face **84** of the casing **31** delimits, with the cavity **120**, two outflow channels for the extinguishing gases. Each channel is linked to an internal volume of the casing by an opening **86** produced in a half-shell **80**A. According to a particular embodiment, the openings **86** preferably pass through the bottom face **84** of the casing **31**. More specifically, each half-shell **80**A respectively comprises an emergent opening **86**. In order to effectively reduce the external manifestations of the extinguishing gases, a filtering block pierced with holes is placed in each outflow channel. By way of exemplary embodiment, a grill **87** is placed on each of the emergent openings **86** of the casing **31**. The bottom rib **805** is preferably protruding relative to the bottom face **84**. According to this particular embodiment, each compartment of the first cavity **120** of the base **110** comprises a hollow rib **121**. The bottom rib **805** protruding from the casing **31** is then arranged in such a way as to be placed in the hollow part of the first cavity **120** of the base **110** at the time of the positioning of the switching block **80** in the modular electrical switching device **1** to delimit two distinct outflow channels. The bottom rib **805** comprises sections of concave and/or convex form. Thus, the bottom face **84** of the unitary switching blocks **80** has a form making it possible to modulate the section of the outflow channel of the gases along this channel so as to alternate areas of expansion and of compression. This alternation of areas of expansion and of areas of compression makes it possible to reduce the quantity of manifestation at the channel outlet. Each compartment of the first cavity **120** is hollow so that the outflow channels for the extinguishing gases comprise walls formed by a part of the bottom face **84** of a unitary switching block **80** and a part of the base **110** of the modular electrical switching device. Each compartment of the first cavity **120** comprises, on a face intended to be placed facing the bottom face **84** of the casing **31** of the unitary switching block **80**. Said face comprises a hollow area **121** in which the bottom rib **805** protruding from said casing is intended to be placed to delimit two distinct outflow channels. Furthermore, each compartment of the first cavity **120** of the base **110** comprises a wall in which two outflow holes **122** for the gases are formed. Each hole **122** is linked to one of the outflow channels.

According to a second variant embodiment as represented in FIGS. **14** and **15**, the two half-shells respectively comprise a rib **85** on their main face **81**. The ribs **85** are preferably set back relative to the main faces **81**. The casing **31** comprises two ribs **85** developing in a direction parallel to the longitudinal plane XZ. Said ribs are intended to collaborate with a first cavity **120** of a base **110** of a modular electrical switching device **1**. Each channel is linked to an internal volume of the casing by an opening **86** produced in a half-shell **80**A. According to a particular embodiment, the openings **86** preferably pass through the bottom face **84** of the casing **31**. More specifically, each half-shell **80**A respectively comprises an emergent opening **86**.

The base **110** further comprises an outer face intended to collaborate with a frame or fixing rail of DIN rail type.

According to one embodiment, the outer face comprises a second cavity **130** having an internal volume delimited by a wall. Said second cavity **130** is thus positioned between the outer face of said base **110** and the first cavity **120** intended for the positioning of a switching block **80**.

According to one mode of development of the invention, the second cavity **130** comprises first openings emerging respectively in main walls of the modular contactor **1** and second connecting openings **132** emerging in proximity to the connection lands **45** of the modular contactor **1**.

By way of exemplary embodiment, the first openings of the second cavity **130** are preferably produced in a breakable wall of the base **110**. Depending on the use of the modular electrical switching device, the breakable part is removed or is not removed. As represented in FIGS. **1** and **2**, according to a first embodiment, the breakable parts have not been removed. As represented in FIGS. **21** and **22**, the breakable parts of the bases **110** have been removed on the two main faces of the switching device in order to leave a passage for electrical conductors **301**.

The first and second openings allow the passage of electrical conductors **301** linking at least one electrical pole of a first modular contactor **1** to an electrical pole of a second modular contactor **2** placed against the first.

According to an embodiment represented in FIGS. **21** to **25**, the internal volume of the second cavity **130** is of substantially parallelepipedal form and has an open face on the outer face of the modular contactor **1**, **2**.

According to a first particular embodiment as represented in FIGS. **21** to **27**, the second cavity **130** comprises at least one channel having an edge comprising at least one connecting opening **132** emerging at a connection land **45** of a unitary switching block **80**. Said at least one channel extends in a direction substantially at right angles to the longitudinal plane XZ and passes entirely through the base **110** to emerge on either side of said base. By way of exemplary embodi-

ment, said at least one channel comprises a substantially parallelepipedal volume having two substantially parallel edges.

Preferably, the second cavity **130** comprises two substantially identical channels arranged parallel to one another. The channels respectively have a parallelepipedal form. The internal volumes of each channel then comprise first openings emerging respectively in the main walls of the modular contactor **1**, **2** and second connecting openings **132** emerging in proximity to the connection lands **45** of the modular contactor **1**, **2**. Furthermore, the two channels are separated by a partition. Said partition is intended to separate the upstream from the downstream. Said partition can be intended to collaborate with a fixing rail of DIN rail type. Thus, when the second cavity **130** comprises two channels, only one of the two edges of each channel comprises the connecting openings **132**. The second connecting openings **132** of a first channel emerge in proximity to the connection lands upstream of the modular contactor **1**, **2** and the second connecting openings **132** of a second channel **130** emerge in proximity to the connection lands upstream of the modular contactor **1**, **2**.

When the second cavity **130** comprises a single channel of parallelepipedal form, the connecting openings **132** are arranged in the two parallel edges of the channel, each edge comprising, respectively, the connecting openings suitable for being passed through by one of the reversing bars of the reversing bar set.

According to a second particular embodiment not represented, the second cavity **130** comprises two slots cut respectively in the lateral faces of the base **110**. These slots emerge respectively at the connection lands **45** of the unitary switching blocks **80**. Each slot is intended to receive a complete reversing bar set **300** comprising one or more reversing bars **301**.

As represented in FIG. **1**, the modular electrical switching device **1** can further comprise one or more fault detection devices, notably thermal. The detection devices are linked to the actuation block **200** in order to control the opening of the electrical contacts via the actuator. According to an embodiment of the invention as represented in FIG. **1**, the modular electrical switching device **1** comprises a removable thermal protection module **400**.

As represented in FIGS. **1** and **2**, a removable thermal protection module **400** according to the invention comprises a casing in which one or more current sensors of annular form are positioned. Said sensors are intended to be positioned around the connection lands **45** of the unitary switching blocks **85** of the switching block **100**. The current sensors can be of Rowgoski type. According to a particular embodiment represented in FIGS. **1** and **2**, the removable thermal protection module **400** is adapted to a three-pole modular contactor and thus comprises three openings **401** allowing it to be positioned by fitting on the connection lands **45** of the three single-pole switching blocks **85**. As represented in FIG. **2**, the removable thermal protection module **400** has the particular feature of being incorporated in the modular contactor **1** in such a way as to be inserted between the switching block **100** and the connection terminal blocks **500**.

The removable thermal protection module **400** according to the invention has the particular feature of not having specific electrical power supply means. According to a preferential embodiment of the invention, the removable thermal protection module **400** comprises communication and electrical power supply means **402** intended to be connected automatically with the removable electrical control module **250** of the actuation block **200**. Thus, these communication and electrical power supply connection means **402** are suitable for both powering the removable thermal protection module **400** and for transmitting the measurements performed by the current sensors. According to this embodiment of the invention, the positioning of the removable electrical control module **250** on the casing of the actuation block **200** allows the automatic connection and electrical power supply between the current sensors of the removable thermal protection module **400** and the removable electrical control module **250**.

According to a preferential embodiment of the invention, the means for rapidly fixing the actuation block **200** with the switching block **100** comprise a first part secured to the mobile keeper **202** of the actuation block **200** and a second part secured to the switching block **100**.

The rapid fixing means comprise at least one coupling hook **214** intended to fix and secure the switching block **100** to the actuation block **200**.

Said coupling hook **214** is secured to the mobile keeper **202** of the electromagnetic actuator and is suitable for collaborating with an actuation device **34** of the mobile contact **33** of the switching block **100** to transmit the movement of the mobile keeper **202** to the mobile contact **33**.

Thus, according to a preferential embodiment of the invention, the coupling hook **214** is intended to both fix the actuation block **200** with the switching block **100** and transmit the movement of the mobile keeper **202** from the electromagnetic actuator to the mobile contact bridge **33** of a unitary switching block **80** of the switching block **100**.

The actuation device **34** of the mobile contact **33** comprises a mobile contact-holder **38** secured to the mobile contact **33**. Said mobile contact-holder **38** is linked to an attachment head **51**. According to an embodiment of the invention, the mobile contact **33** is preferably slidingly mounted on the mobile contact-holder **38**.

Contrary to the known solutions, the mobile contact-holder **38** forms an integral part of the unitary switching block **80** and does not form part of the mobile part of the electromagnetic actuator of the actuation block **200**. Each unitary switching block then respectively comprises a mobile contact-holder **38** secured to the mobile contact **33**. As represented in FIG. **2**, the switching block **100** of the modular contactor **1** according to the invention comprises three unitary switching blocks **80** respectively having a mobile contact-holder **38**. Each unitary switching block then has autonomous operation relative to the other unitary blocks.

According to one embodiment, the coupling hook **214** comprises an inner surface having a first and a second edge respectively comprising bearing surfaces suitable for transmitting the movements of the mobile keeper **202** to the mobile contact from a closed position to an open position and vice versa.

The coupling hook **214** preferably has a C-shaped profile having two substantially parallel edges.

A first edge of the coupling hook **214** comprises a slot which is intended to receive the attachment head **51** secured to the contact-holder **38**. The first edge comprises a bearing surface intended to transmit the movement of the mobile keeper **202** to the mobile contact-holder **38** of the mobile contact **33** in a first direction of movement, notably from the closed position of the mobile keeper **202** to its open position. A second edge comprises a bearing surface intended to transmit the movement of the mobile keeper **202** to the mobile contact-holder **38** of the mobile contact **33** in a

second direction of movement, notably from the open position of the mobile keeper **202** to its closed position.

According to one mode of development of the invention, the fixing means **210** comprise a tray **211** intended to be fixed to the mobile keeper **202**. According to a particular embodiment, the tray **211** comprises a counterbore on a first face. A part of the mobile keeper **202** is intended to be positioned by countersinking in said counterbore. The fixing means **210** comprise removable securing keys **212** passing through the walls of the counterbore and a part of the mobile keeper **202**. By way of exemplary embodiment, the form of the counterbore of the tray **211** is substantially rectangular to receive the transverse keeper securing the outer branches of the U-shaped mobile keeper of the mobile keeper **202**. Said transverse keeper comprises through-holes allowing the passage of the removable securing keys **212** when fixing the mobile keeper **202** with the tray **211**.

According to a particular embodiment, the tray **211** comprises three coupling hooks **214** intended respectively to collaborate with an attachment head **51** of a mobile contact-holder **38** secured to the mobile contact **33** of a unitary switching block **80**. According to this particular embodiment of the invention, three unitary switching blocks **80** are then controlled in a synchronized manner by the actuation block **200** acting on the unitary switching blocks. As has been specified above, the unitary switching blocks **80** can be controlled in a synchronized and simultaneous manner or a synchronized and non-simultaneous manner. Each unitary switching block **80** is linked to the actuation block **200** and is controlled on the opening of the contacts **32**, **33** by translationally displacing the mobile contact bridge **33** in a direction at right angles to the longitudinal axis X. The mobile contact bridge **33** is displaced between a position of opening and a position of closure of the electrical contacts.

Contrary to the prior art solutions, the coordination on the opening of the different unitary switching blocks **80** is produced directly by the actuation block **200** and not by additional means such as, notably, by control axes linking the unitary switching blocks. Thus, by virtue of the solution of the invention, when the actuation block **200** is detached from the fixing block **100**, each unitary switching block **80** can be directly removed from the base **110** of the fixing block **100**. This removal can be performed independently of that of the other unitary switching blocks **80**.

The modular contactor **1** according to the invention then comprises rapid fixing means **210** allowing the actuation block **200** to be fixed removably to the switching block **100**.

According to a preferential embodiment, the coupling hook **214** comprises play take-up means suitable for eliminating plays necessary for the mounting of the actuation block **200** on the switching block **100**. These play take-up means thus guarantee that a reduced chain of dimensions is observed.

The play take-up means comprise an elastic blade **213** positioned substantially parallel to the second edge of the coupling hook **214**. Said elastic blade **213** behaves like a blade damper by being deformed in the direction Z as soon as it enters into contact with the attachment head **51** linked to a mobile contact-holder **38** secured to a mobile contact **33**. In other words, the play take-up is produced in such a way that it makes it possible to avoid the relative displacements of the different parts during the electrical or mechanical maneuvers of the modular contactor. The play take-up means thus make it possible to achieve high levels of mechanical durability. According to a variant embodiment not represented, a single elastic play take-up blade could be used and then be common to all three unitary switching blocks.

According to an embodiment as represented in FIG. **5**A, the elastic blade **213** is positioned in a housing of the tray **211**. The elastic blade **213** is preferably metallic and is produced by folding. Said blade comprises positioning snugs intended to be placed inside the tray **211** in order to limit any displacement of said blade.

The elastic blade **213** has a dual function. It makes it possible on the one hand to recover the play between the tray **211** and attachment head **51** and, on the other hand, recover the play between the tray **211** and the mobile keeper **202** of the electromagnetic actuator. The wavy form of the elastic blade **213** has the effect of locating the attachment head **51** in the axis of the mobile assembly **220** and of allowing the installer to feel a snap-fitting or hard point sensation confirming the correct assembly of the two parts to one another.

According to one embodiment of the invention, as represented in FIGS. **4**, **5** and **6**, each mobile bridge **33** of a unitary switching block **80** comprises an attachment head **51** intended to be linked to a coupling hook **214** of a tray **211** of a mobile keeper **202** of the electromagnetic actuator. The attachment head **51** comprises bearing surfaces intended to collaborate with the bearing surfaces of the two edges of the C-shaped coupling hook **214**. According to one particular embodiment, the attachment head comes to be positioned between the two edges of the coupling hook **214**. The attachment head **51** is linked to the mobile contact-holder **38** by a transmission axis **52**. The transmission axis **52** then comes to be positioned inside the slot of the first edge of the coupling hook **214**.

According to a preferential embodiment of the invention, the position of the attachment head **51** can be adjusted according to the direction of displacement of the mobile contact bridge **33**, in other words in a direction at right angles to the longitudinal axis X. This adjustment makes it possible to optimize the contact compression travel between the electrical contact areas **37** of the two fixed contacts **32** and the contact areas **36** of the mobile contact bridge **33**.

The mobile contact bridge **33** of each unitary switching block **80** is displaced between a position of opening and a position of closure of the electrical contacts. The aim is to guarantee that, for a given displacement travel, the electrical contacts are indeed in the position of closure. The displacement travel is set by the electromagnetic actuator of the actuation block **200**.

Depending on the manufacturing tolerances of a unitary switching block **80**, the distance separating the mobile contact bridge **33** from the fixed contacts **32** in the position of opening of the contacts can vary from one unitary switching block **80** to another.

Thus, for one and the same displacement travel of the actuator of the actuation block **200**, the final positions of the mobile contact bridges **33** can be different. For a multiple-pole contactor having a single actuator simultaneously controlling a number of mobile switching bridges **33**, it is possible for all the mobile switching bridges not to have reached the same position of closure. In other words, by way of example, a mobile switching bridge **33** of a unitary switching block **80** may not be totally in a position of closure whereas the other mobile bridges **33** of the other unitary switching blocks are already in a position of closure.

Setting the compression travel of the contacts consists in guaranteeing that a mechanical dimension will be kept between the attachment head **51** and the casing **31** of the unitary switching block **80** in the position of closure of the

contacts. More specifically, setting the compression travel of the contacts consists in guaranteeing that a dimension is kept between the bearing surfaces of the attachment head **51** and a reference surface of the casing **31** of the unitary switching block **80**. This dimension will be reproduced for all the unitary switching blocks of one and the same modular contactor **1** according to the invention.

The compression travel is set using the transmission axis **52** linking the attachment head **51** to the mobile contact-holder **38**. According to one embodiment of the invention, said transmission axis **52** is of variable length.

According to a particular embodiment of the invention, the transmission axis **52** comprises a first end fixed to the attachment head **51** and a second end comprising a threading. The threading is intended to collaborate with a tapping produced in the mobile contact-holder **38** secured to the mobile contact bridge **33**. By screwing the transmission axis **52** more or less into the mobile contact-holder **38**, the attachment head **51** is displaced relative to the casing **31** of the unitary switching block **80**.

By way of exemplary embodiment of the attachment head **51**, the latter comprises a cavity intended to collaborate with a setting tool (not represented). The setting tool is intended to be manipulated by a user wanting to set the length of the transmission axis **52**. As represented in FIGS. **2** and **10**A, the attachment head can comprise, for example, a dome-headed profile. As represented in FIG. **16**, the attachment head can comprise, for example, a hexagonal profile.

The method for setting the compression travel of the electrical contacts of a unitary switching block **80** consists in placing the mobile contact-holder **38** in a position of closure of the electrical contact **32**, **33**. The compression travel of the contacts can also be called wear guard. This operation is generally performed manually before the casing **31** of the unitary switching block **80** is mounted on the base **111** of the switching block **110**. The next step consists in positioning a setting template **600** between the outer surface of the casing **31** and a bearing surface of the attachment head **51**. If the distance between the casing and the attachment head **51** is less than the thickness of the setting template **600** and does not allow the positioning of said template, the transmission axis **52** is then lengthened notably by unscrewing it relative to the casing **31**. Conversely, if the distance between the casing **31** and the attachment head **51** is greater than the thickness of the setting template **600**, the transmission axis **52** is then shortened notably by screwing it relative to the casing **31**. When the length of the transmission axis **52** has been set, the setting template **600** can be removed.

According to a particular embodiment of the setting method, as represented in FIGS. **6**A and **6**B, the first step consists in increasing to the maximum the length of the transmission axis **52**, notably by unscrewing it to the maximum. The second step as represented in FIGS. **7**A and **7**B, consists in positioning the setting template **600** between a bearing surface of the attachment head **51** and a reference surface of the casing **31** of the unitary switching block **80**. In a third step, the mobile contact-holder **38** is then brought into a position of closure of the electrical contacts **32**, **33** by screwing the transmission axis **52**. As represented in FIGS. **8**A and **8**B, the attachment head **51** finishes by bearing on the setting template **600** and the mobile contact-holder **38** is in the position of closure. In a final step represented in FIGS. **9**A and **9**B, the setting template **600** is removed and the mobile contact-holder **38** is positioned in a position of opening of the contacts **32**, **33**.

According to one embodiment of the invention, the presence of a transmission axis **52** of variable length on each unitary switching block **80** also makes it possible to create a temporal offset or a synchronization in the opening of the mobile contacts **33** of the unitary switching blocks **80** of one and the same modular switching device according to the invention.

This time offset in the opening of the electrical poles of a modular switching device notably makes it possible to reduce the wear of the contacts on the opening of a three-phase product, by deliberately advancing the opening of one pole relative to the other two.

In effect, in three-phase switching, there is always one electrical pole which switches before the other two. The other two poles then cut off a network which has become single-phase following the first switching. The offset makes it possible to guarantee the three-phase switching always on the same pole that can then be synchronized relative to the zero current. The opening of the other two poles is offset so as to reduce to the maximum the arc time on these two poles.

This time offset in the opening of the electrical poles of a modular switching device also makes it possible to guarantee, for certain four-phase applications, an advance or a delay in the opening of the neutral relative to the phases.

According to another embodiment of the setting method, this operation can be performed simultaneously for all the unitary switching blocks **80** positioned in a unitary, two-pole, three-pole or four-pole base. A template associated with the number of poles present is then used. In this same embodiment, a time offset in the opening of one or more poles can easily be produced by a template incorporating the offset of the pole for which the closure has to be advanced or delayed.

Thus, by virtue of the rapid fixing means, the mounting and/or the dismantling of the switching block **100** relative to the actuation block **200** can be performed easily which facilitates, for example, maintenance interventions notably on the switching block.

Furthermore, the positioning references of the actuation block **200** relative to the preset unitary switching blocks of the switching block **100** make it possible to guarantee a very reduced tolerance of the wear guard of the contacts and do so in the event of the changing of the unitary blocks as part of the maintenance intervention. The wear guard of the contacts is also called contact compression. This then has the effect of guaranteeing a low tolerance on the electrical endurance despite the manufacturing tolerances of any industrial product, and simultaneously allowing for a saving of contact material (silver-based) and a lower consumption of the actuator.

As represented in FIG. **2**, the modular contactor **1** according to the invention comprises connection terminal blocks **500** intended to be connected to the connection terminals **45** of the switching block.

According to a particular embodiment of the invention as represented in FIGS. **28**A to **30**B, the electrical switching device **1** comprises additional removable auxiliary contact blocks **700**. These blocks have the particular feature of being removable.

The removable auxiliary contact blocks **700** comprise a mobile contact support MCS which is controlled upon opening either by the operating axis **216** of the mobile assembly **220** through the tray **211** being displaced in a translational movement or by the multifunction lever **205** being displaced in a rotational movement.

According to an exemplary embodiment as represented in FIGS. **28**A and **28**B, the removable auxiliary contact blocks **700** are controlled by a translational movement of the mobile assembly **202** to indicate the open or closed state

NO/NC of the electrical switching device **1**. Said add-on block is mounted vertically relative to the position of installation.

According to an exemplary embodiment as represented in FIGS. **29**A and **29**B, the removable auxiliary contact blocks **700** are controlled by a rotational movement of the multifunction lever **205**. The add-on blocks are mounted frontally relative to the position of installation.

According to a variant embodiment as represented in FIGS. **30**A and **30**B, the multifunction lever **205** can offer the possibility, via a particular form of flag type, of indicating the state of opening of the electrical switching device **1**. This mechanical visualization of the position of the electrical switching device **1** can be produced by an angular displacement of the lever **205** comprising a flag **208**.

As represented in FIGS. **21** and **22**, the invention relates to a switching assembly **1000** comprising two modular contactors **1**, **2** as defined above. Said modular contactors **1**, **2** of the switching assembly **1000** are placed side-by-side so as to be attached by one of their main faces. Furthermore, the two modular contactors **1**, **2** are electrically connected. The switching assembly **1000** comprises electrical conductors **301** positioned respectively inside second cavities **130** of the two bases **110** of the two modular contactors **1**, **2**. The electrical conductors **301** linking the electrical poles of the first modular contactor **1** to the electrical poles of the second modular contactor **2** comprise rigid or semi-rigid conductors **301**.

According to a particular embodiment of the connection assembly, the internal volume of the second cavity **130** is intended to receive sets of reversing bars **300** suitable for linking two modular contacts **1**, **2** according to a reversing switch mode as represented in FIGS. **21** and **22**. As represented in FIG. **22**, the two contactors **1**, **2** linked set by the set of reversing bars **300** are contactors of three-pole type. The set of bars **300** then comprises six reversing bars **301** respectively linking two connection lands **45** of two contactors. As represented in FIGS. **21** to **27**, the electrical conductors **301** of the switching assembly **1000** are arranged in two groups **300** respectively comprising three reversing bars **301**. Advantageously, the electrical conductors **301** of one and the same group **300** are secured by a clamp **302**.

Each connection opening **132** of a second cavity **130** emerging at a connection land **45** of a unitary switching block **80** is then passed through by one of the reversing bars **301** of the set of reversing bars **300**. Thus, each connection opening **132** allows for the passage and the positioning of a reversing bar alongside a connection land **45** in such a way that the electrical contact between the land and the bar can take place. According to this first particular embodiment, as represented in FIGS. **23** to **25**, the placement of the reversing bars **301** of the set of reversing bars **300** is done through the outer face of the base **110**. After having slid the ends of the reversing bars **301** into the connection openings **132**, the set of bars **300** undergoes a slight rotation to come to be positioned inside the second cavity **130**.

According to a second particular embodiment not represented, the placement of the reversing bars **301** of the set of reversing bars **300** is done directly through the lateral face of the base **110**. The set of reversing bars **300** is positioned in the slot of the second cavity **130** by sliding it therein. The ends of the reversing bars **301** are then directly attached to the connection lands **45**.

This three-pole reversing switch mode is particularly suited to the control of electric motors. According to a particular embodiment, an upstream connection land **45** of the first electrical pole of the first modular contactor **1** is linked to an upstream connection land **45** of the first electrical pole of the second modular contactor **2**. Furthermore, a downstream connection land **45** of the first electrical pole of the first modular contactor **1** is linked to a downstream connection land **45** of the third electrical pole of the second modular contactor **2**. An upstream connection land **45** of the second electrical pole of the first modular contactor **1** is linked to an upstream connection land **45** of the second electrical pole of the second modular contactor **2**. A downstream connection land **45** of the second electrical pole of the first modular contactor **1** is linked to a downstream connection land **45** of the second electrical pole of the second modular contactor **2**. An upstream connection land **45** of the third electrical pole of the first modular contactor **1** is linked to the upstream connection land **45** of the third electrical pole of the second modular contactor **2**. Finally, a downstream connection land **45** of the third electrical pole of the first modular contactor **1** is linked to the downstream connection land **45** of the first electrical pole of the second modular contactor **2**.

Furthermore, this embodiment can be applied to four-pole contactors (not represented) intended for the reversal of electrical power sources.

Thus, according to the connection mode in reversing switch mode of two modular contactors according to the invention, the two sets of bars **300** are placed inside the contactors. This innovative configuration makes it possible to not increase the overall volume of the electrical installation. This offers a significant advantage over the prior art solutions where the installation of the sets of bars outside (FIG. **19**) leads to problems at the time of the wiring of the contactors in the electrical cabinets. In effect, the space inside these electrical cabinets is always limited.

Furthermore, this configuration of the sets of reversing bars inside the modular contactors **1**, **2** according to the invention also makes it possible to incorporate a removable measurement and thermal protection module **400** in one of the two modular contactors **1**, **2** as is represented in FIGS. **21** and **22**.

This incorporation of a removable thermal protection module **400** on one of the two contactors **1**, **2** is impossible with a known wiring as represented in FIG. **19**. In effect, if a user tries to convert the wiring of two contactors placed in a mode of reversing switch type as represented in FIG. **19** by incorporating the thermal protection (thermal relay) on one of the two contactors then, as represented in FIG. **20**, a non-functional wiring is obtained. In effect, according to this unsatisfactory embodiment, when the motor is powered by contactor number **2**, the thermal relay is no longer on the current flow and cannot therefore indicate the thermal state of the motor.

As represented in FIGS. **21** and **22**, one of the modular contactors **2** of the switching assembly **1000** does not include any removable thermal protection module **400**. Said modular contactor **2** comprises an actuation block **200** associated with a switching block **100** not equipped with a removable thermal protection module **400**.

The invention is particularly intended for the multiple-pole switching apparatuses of the contactor or starter type with electronic control. The architecture with simplified modular structure of these apparatuses makes it possible to accept one or more switching bocks, as well as a removable thermal protection in the volume of the device. This architecture allows for easy and differentiated maintenance of the various modular elements, whether electrical, electronic or electromechanical.

The invention claimed is:

1. A modular electrical switching device comprising:

a switching block comprising unitary switching blocks respectively comprising at least one fixed contact that can collaborate with a mobile contact;

an actuation block of the unitary switching blocks comprising an electromagnetic actuator comprising a fixed yoke and a mobile keeper configured to be displaced with respect to the fixed yoke between an open position and a closed position of the electrical contacts;

means allowing the actuation block to be fixed onto the switching block;

rapid fixing means allowing a removable fixing of the actuation block onto the switching block, the rapid fixing means comprising at least one coupling hook configured:

to fix and secure the switching block to the actuation block, and

to collaborate with an actuation device of the mobile contact of a unitary switching block to transmit movement of the electromagnetic actuator to the mobile contact,

the coupling hook being secured to the mobile keeper of the electromagnetic actuator.

2. The modular electrical switching device as claimed in claim 1, wherein the actuation device of the mobile contact of a unitary switching block comprises a mobile contact-holder secured to the mobile contact, the mobile contact-holder comprising a snug supporting an attachment head.

3. The modular electrical switching device as claimed in claim 2, wherein the coupling hook comprises an edge comprising a bearing surface configured to collaborate with the attachment head to transmit movements of the mobile keeper to the mobile contact from the closed position to the open position and vice versa.

4. The modular electrical switching device as claimed in claim 3, wherein the coupling hook comprises a first edge comprising a slot configured to receive an attachment head of the snug, the first edge comprising a bearing surface configured to transmit movement of the mobile keeper to the mobile contact-holder of the mobile contact in a first direction of movement from the closed position to its open position.

5. The modular electrical switching device as claimed in claim 3, wherein the coupling hook comprises a second edge comprising a bearing surface configured to transmit movement of the mobile keeper to the mobile contact-holder of the mobile contact in a second direction of movement, from the open position to its closed position.

6. The modular electrical switching device as claimed in claim 2, wherein the attachment head of the snug is mobile relative to the mobile contact-holder, the attachment head configured to be displaced in a direction parallel to a direction of displacement of the mobile contact-holder.

7. The modular electrical switching device as claimed in claim 6, wherein the attachment head is linked to the mobile contact-holder by a transmission axis of variable length.

8. The modular electrical switching device as claimed in claim 7, wherein the transmission axis comprises:

a first end fixed to the attachment head, and

a second end comprising a threading configured to collaborate with a tapping produced in the mobile contact-holder secured to the mobile contact.

9. The modular electrical switching device as claimed in claim 5, wherein the coupling hook comprises play take-up means for eliminating plays necessary for mounting of the actuation block on the switching block so that a reduced chain of dimensions is observed in a direction of displacement of the mobile contact-holder.

10. The modular electrical switching device as claimed in claim 9, wherein the play take-up means comprises an elastic blade positioned substantially parallel to the second edge of the coupling hook, the elastic blade behaving like a blade damper by being deformed in a direction of displacement of the mobile contact-holder as soon as it enters into contact with the attachment head of a snug secured to the mobile contact-holder.

11. The modular electrical switching device as claimed in claim 1, comprising three unitary switching blocks, actuation devices of the blocks being respectively controlled in a synchronized manner by the actuation block to control opening of the electrical contacts.

12. The modular electrical switching device as claimed in claim 11, wherein the actuation block comprises a tray fixed to the mobile keeper, the tray comprising three coupling hooks configured respectively to collaborate with an attachment head of a snug of a mobile contact-holder secured to the mobile contact of a unitary switching block.

13. The modular electrical switching device as claimed in claim 1, further comprising a removable electrical control module positioned and fixed removably onto a casing of the actuation block, the module comprising electronic control means for ensuring a repetitive and constant operation of the actuator for a wide power supply voltage range.

14. The modular electrical switching device as claimed in claim 13, further comprising a removable thermal protection module comprising a casing in which at least one current sensor is configured to be positioned around a connection land of a unitary switching block, the module being inserted removably between the switching block and connection terminal blocks and comprising communication and electrical power supply means configured to be connected automatically with the removable electrical control module to be self-powered and to transmit measurements performed by the current sensors.

15. An electrical switching assembly comprising a first and a second modular electrical switching device as claimed in claim 1, the devices placed side-by-side being electrically connected, and comprising electrical conductors positioned respectively in second cavities of two bases of the two modular devices.

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